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DIRECT CONNECTED RAILWAY GENERATORS.

THE attention given the designing of railway generators by the General Electric Company has resulted in improvements which have brought this type of machine well toward perfection. These machines operate sparklessly over a remarkable range of loads, are free from heating and burn-outs under all but the most severe abuse, and give no trouble with ordinary attention. The external circular yoke of the field, in all machines of this type, is made of cast iron, and has an oval cross section, except in very large machines, where it is cast with a box-like cross section to give greater stiffness. The upper half of the field is fastened to the lower half by bolts entirely hidden within recesses cored in the side supports, thus doing away with side flanges and improving the appearance of the machine.

The poles are solid steel castings with their outer ends machined to fit accurately the planed faces projecting inwardly from the magnet frame. The use of circular poles of a solid material of high permeability minimizes the length of turns of the field winding, and reduces the waste in this part of the machine.

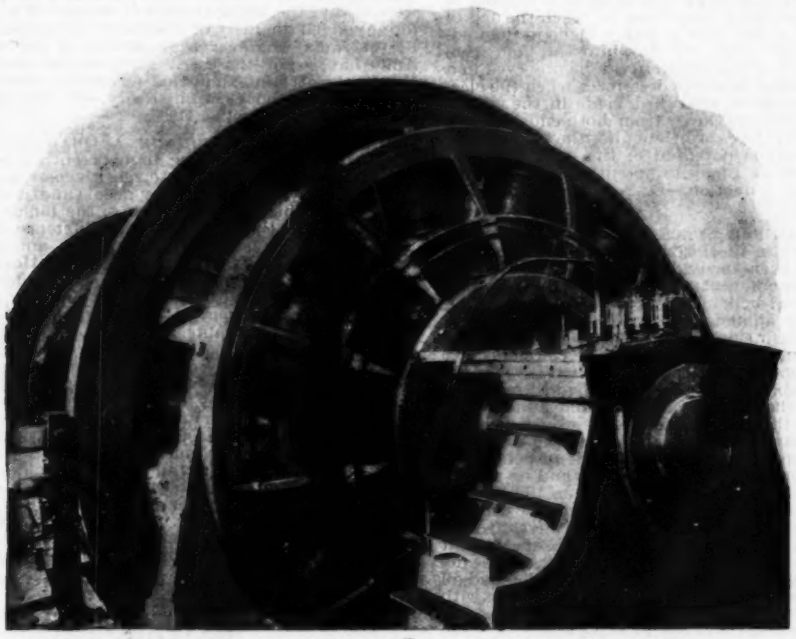
The poles are bolted to the frame, and are also keyed in such a way that they may be slipped out laterally without disturbing either the armature or the field ring.

To reduce the heating of the poles due to the movement of lines of magnetic force with the armature teeth, the poles of all machines with a capacity of 200 kilowatts or more are provided with laminated faces. These faces are extended into pole tips, in order to make the area of the air gap greater than the cross section of the pole and thereby diminish the density in the teeth and, consequently, the iron losses and heating in this part of the machine. The pole tips serve also as a convenient means of holding the field coils in place, doing away with any special devices for this purpose. The pole tips are designed to give a graduated field in which the plane of sparkless commutation can be easily found.

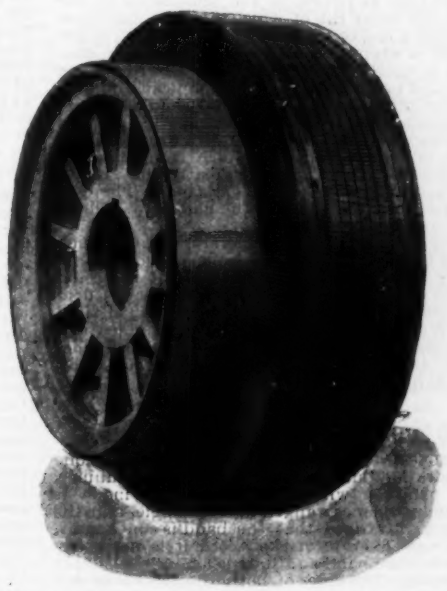
Each arm of the armature spider is cast with its own section of the spider rim, and the rim sections are unconnected except through the hub, until the laminations are dovetailed to them; thus shrinkage strains in the castings are avoided. The arms have wings or fan blades cast to them, which are inclosed by deep extensions of the end flanges toward the shaft. These wings, with the radial space blocks in the ventilating passages between the laminations, serve as a forcible centrifugal fan to keep a constant blast of air passing between the laminations and windings and around the poles, thus keeping all parts well ventilated and cool.

The coils are of the usual form-wound copper strip type, held in the slots by wooden retaining wedges, which are sufficient for all ordinary strains, and also by binding bands over the ends, which give added strength for emergencies, such as a runaway of the prime mover. These binding bands are sectional and are fastened with a key, by means of which they may be readily removed or replaced. There are no binding bands on the armature surface under the poles.

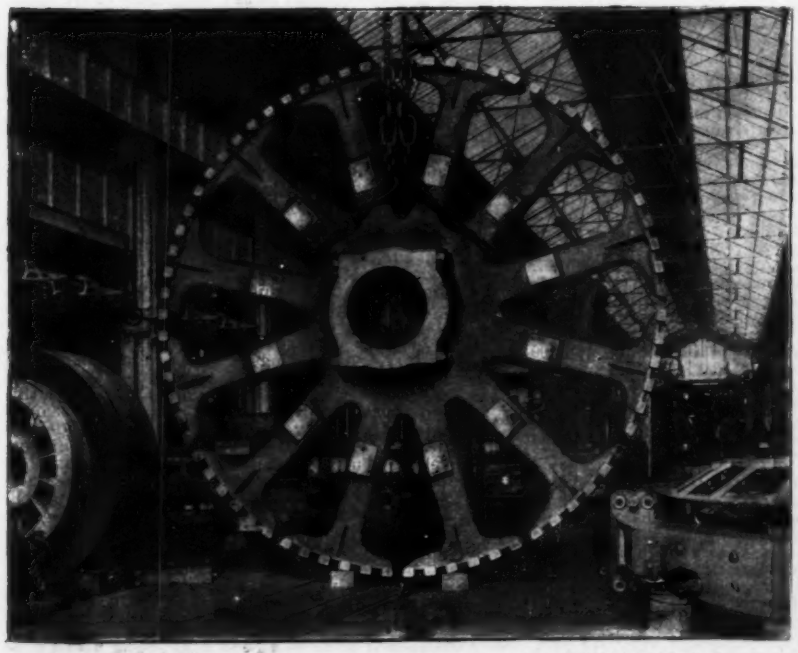
The rear end of the winding where the soldered joints are located overhangs the end flange and is



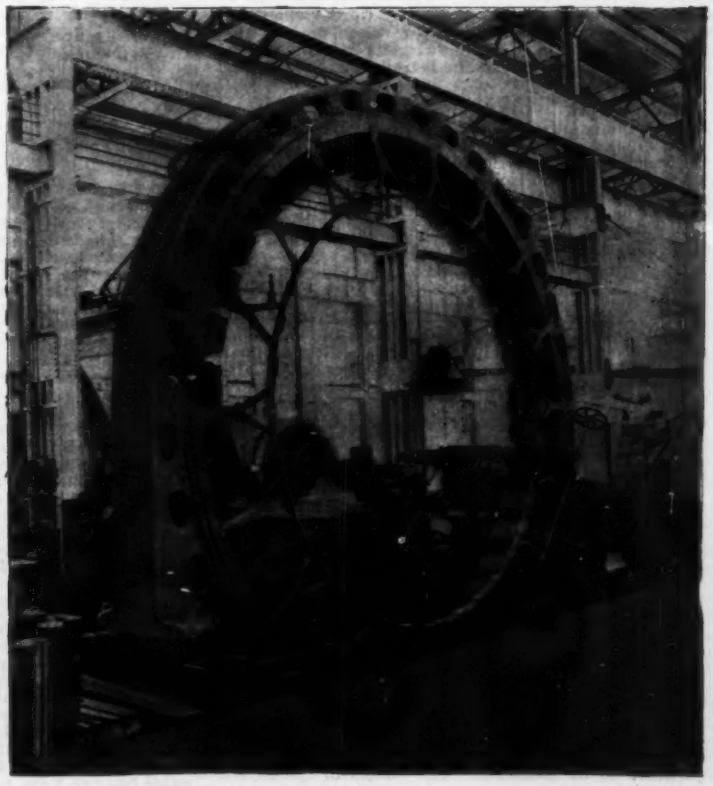
550-KILOWATT DIRECT CONNECTED RAILWAY GENERATOR



FRONT VIEW OF ARMATURE AND COMMUTATOR.



SPIDER CASTING FOR 2,700-KILOWATT RAILWAY GENERATOR.



FIELD FRAME OF 2,700-KILOWATT RAILWAY GENERATOR.

kept cool by an air blast sent out by wings on the end flange.

All armatures having a multiple winding are cross connected between points of equal potential by means of equalizer rings, through which alternating currents will flow between sections under poles of different strengths. These currents equalize the pole strengths all around the armature and cause an equal division of the direct current between the several paths. Thus, in case the armature settles out of center, due to the wear of the bearings or other cause, the difference in the air gap above and below the armature gives no trouble, the strength of all poles remaining the same. For the same reason there is no unbalanced magnetic pull tending to bend the shaft and increase the bearing friction. The distribution of the magnetism is also rendered the same under all of the poles, the effect of which is to improve the commutation. These equalizer rings are mounted on an end flange at the back of the armature, where they are open to inspection.

The commutators of these machines are made with no ring of insulation rising above them at the front end. This leaves the entire surface free for turning off or polishing. The same form of steel clamping ring is used behind and in front of the commutator, giving a strong material at both ends of the commutator to resist centrifugal force, and assure safety in case of excessive speed. In large machines these clamping rings are made sectional, allowing each part of the commutator to be independently clamped, or loosened for the removal of a segment, without disturbing the other sections of the commutator.

The support for the brush holders consists of a cast iron latticed ring, as shown in the illustration of the field frame, the outer rim of which fits in a machined seat in the front end of the magnet frame. Each brush holder stud is supported at both ends. These supports hold it rigidly against any tendency to vibrate or chatter, and protect it against mechanical injury.

The carbon brushes are held in solid shank holders, in such a manner that they can follow any inequalities of the commutator surface without tilting and making contact on one edge. Tilting, which is inherent in spring-supported brushes, reduces greatly the area of brush contact, and causes intense heating. The current is carried from the brush to the holder by a flexible copper connecting cable.

The series coils of railway generators are of such strength as to raise the voltage from 525 volts at no load to 575 at full load when full current is passed through the series field. By shunting the series field this over-compounding can be reduced to any desired amount. With proper governors on the engines, machines in parallel with each other divide all load fluctuations in exact ratio with their relative capacities without manipulation of the field rheostats.

CONTEMPORARY ELECTRICAL SCIENCE.*

NEW TELEGRAPHONE.—An improved telegraphone for demonstration purposes is described by E. Ruhmer. The steel band on which the records are made is wound on four rollers arranged in a rectangle, and the winding is so arranged that the band is continuous, and for a reproduction of the record it is not necessary to reverse the band and start it again, but simply to let it run on. The cores of both the recording and reproducing magnets are parallel to the breadth of the band, and not perpendicular to its surface. They are made to touch it. For the guidance of the wires, four brass combs are mounted near the rollers. The whole apparatus is driven by a $\frac{1}{4}$ horse power electromotor, which imparts to the band a velocity of 3 m. per second. The duration of speech is two minutes. That is not much for a phonograph, but, of course, it can be increased by increasing the number of rollers or the distance between them. Several hearing magnets can be arranged, and if it should be necessary to repeat a short passage, that can be done by mounting a hearing magnet on another part of the wire, and switching it on as required. The author mentions a German sentence, giving the same words when reversed, which he has successfully reversed on this apparatus. It is: Ein Neger mit Gazelle zagt im Regen nie.—E. Ruhmer, Physikal. Zeitschrift, October 6, 1900.

TERRESTRIAL MAGNETISM IN FRANCE.—Starting from Toulouse Observatory as a center, E. Mathias has made a detailed survey of the distribution of the magnetic elements in the South of France, with special reference to the horizontal intensity, which shows a more regular gradation than the other elements. Instead of plotting the isodynamics on a map, he makes the difference in H a function of the latitude and longitude, thus

$$\Delta H = x(\Delta \text{ long.}) + y(\Delta \text{ lat.})$$

and determines the coefficients, x and y. The mean of 54 observations distributed over eight Départements surrounding Toulouse yields —1·26 for x and —7·42 for y, ΔH being expressed in units of the fifth decimal order and for the epoch 1896, and differences of latitude and longitude being expressed in minutes of arc. These values are not merely of local interest. By means of the coefficients, which are practically the same for the whole of France, and possibly for a larger area, the author has re-determined Moureaux's experimental values and found his own values to agree with them within the errors of observation. Declination values treated similarly do not yield simple coefficients, as the declination, and the dip too, are affected by considerable irregularities, such as the maximum over Corsica.—E. Mathias, Comptes Rendus, October 1, 1900.

PLATINUM THERMOMETRY.—An important piece of work has been carried out at the Kew Observatory in connection with platinum thermometers. C. Chree reports on a series of tests of six platinum thermometers by means of a Callendar-Griffiths resistance bridge. He enumerates no less than 13 sources of error which may affect the measurements, among them being thermo-electric currents, heating due to the battery current, error in the temperature coefficient, insufficient immersion and slowness in acquiring the temperature to be measured. The effects of insufficient immersion are as dangerous in platinum thermometry as they are in mercury thermometry. Heat is conducted in from the outer air through the leads, or outward in case of high temperatures. Unless the total immersion exceeds 10 cm., the error is likely to exceed 0·01° C. The platinum thermometers tested were found to be four or five times slower in acquiring the temperatures to which they were exposed than mercury thermometers. An immersion of 3·5 minutes in ice and 2·5 minutes in steam suffices to bring the reading within 0·0005 of its stationary value. The author suggests a number of further experiments to determine the effect of long exposures to high and to low temperatures, the variation of the boiling point of sulphur, and the behavior of new platinum thermometers under a variety of conditions.—C. Chree, Proc. Roy. Soc., No. 435, October 3, 1900.

HIGH RESISTANCES.—The usual method of measuring resistances, viz., that in which a current is sent through them and measured by a galvanometer, and in which the whole of the joulean waste takes place within the bad conductor itself, and not in the surrounding medium, fails when the resistance becomes about 10,000 megohms. It is just at that point that the "loss of charge method" begins to be useful. O. N. Rood is making an interesting series of experiments with the latter method, in which one of the ends of the bad conductor is attached to one coating of a charged condenser, and the other to a sensitive aluminium-leaf electroscope, which hands on to the earth any charge that succeeds in reaching it. The current observed has many striking analogies to a current of pitch. The latter takes some time to reach the end of its path, and if at any time a leak is made in the middle of the path, the pitch will flow into the hole from both sides. Such a phenomenon can be observed in a glass rod, connected as above described, when the electroscope connection is afterward made in the middle of it. Electricity flows slowly from both ends into the new channel. In the case of ebonite, the electroscope end never attains the potential of the condenser end. It often acquires an opposite potential, probably due to some kind of induction.—O. N. Rood, Am. Jour. Science, October, 1900.

SIMPLE RELAY FOR SPACE TELEGRAPHY.—A simplified relay for use in Hertzian wave and coherer experiments has been devised by W. B. von Czudnochowski. Its general construction resembles that of an electric trembling bell. The axes of the electromagnets are horizontal, and the "trembler" hangs vertically down by their side. Its extreme point is provided with a platinum contact attached to a German-silver arm. The armature is rather heavy, and is weighted with an adjustable brass ball. It is covered with tissue paper next the magnet, and to avoid adhesion as far as possible the contact piece is so adjusted that it touches the insulated electrode before the armature touches the magnets. The armature is suspended by means of a thin German-silver spring, and its normal distance from the magnets is only 1 mm. The whole apparatus is very cheap, and quite sensitive enough for most wave experiments. Thus the waves from a small Hertzian oscillator consisting of two straight cylinders 5 cm. long and 1 cm. in diameter can be detected over a length of 30 meters or 40 meters, and all the Hertzian reflection experiments can be made with it. It is even found that in the case of vertical propagation three ceilings, worked in stone and iron, when interposed in the path of the waves, do not sensibly affect the indications of the relay. Its sensitiveness can be readily adjusted.—Von Czudnochowski, Physikal. Zeitschrift, October 6, 1900.

CONTACT E. M. F. OF MERCURY.—Nernst's theory leads to the conclusion that two normal solutions of sodium chloride and potassium chloride, respectively, should show the same difference of potential in contact with mercury or mercury powdered over with calomel. M. Rotté has verified this equality in a very direct manner by means of a capillary electrometer in which he employed the two solutions mentioned. He determined the E. M. F. at various capillary forces, and found the E. M. F. corresponding to a maximum capillary force graphically from the curve. For common salt the maximum E. M. F. was found to be 0·56 volt. For potassium chloride it was found to be 0·562 volt. This is a striking verification of Nernst's theory, especially considering that the same figures were obtained with the apparatus when sulphuric acid was filled in and withdrawn after each determination.—Rotté, Jour. de Physique, October, 1900.

TESTING OF THERMO-COUPLES.—The Reichsanstalt method of testing thermo-couples intended for pyrometric work is described by S. Lindeck and R. Rothe. The chief innovation in the testing arrangement is an electric oven, consisting of four concentric porcelain tubes, only the outermost of which is glazed and covered with asbestos. The inner tubes are made of a very refractory material devised by Hecht. For temperatures up to 1,400° the second tube is wound with a 3-mm. pure nickel wire, prevented from rusting by covering it with fireclay paste. For still higher temperatures the wire employed for heating is a platinum-iridium wire, by means of which a temperature as high as 1,600° can be attained. When that temperature is exceeded, the wire fuses into the porcelain. The temperature can be regulated with great rapidity and precision, the fine regulation being made by means of a sliding contact on a Constantan band. The power consumed is 60 watts at 200° and 1,540 watts at 1,300°. A number of couples are tested simultaneously by means of a compensation method, the junctions being fastened by friction into a small circular gapped piece of platino-iridium. The errors of the measurements do not exceed 0·1 per cent.—Lindeck and Rothe, Zeitschr. Instrum., October, 1900.

REPULSION DUE TO SOLAR RADIATION.—It was Kepler who endeavored to explain comets' tails by the repulsion exercised upon certain constituents of comets by the particles constituting light. The general acceptance of the undulatory theory of light has made us lose sight of Kepler's suggestion, but the radiation-pressure postulated by Maxwell's theory of light can be made to bring it forward again very effectually. This is done by S. Arrhenius. He calculates that a cubic body of 1 cm. side and specific gravity 1 would, in the immediate neighborhood of the sun, lose $\frac{1}{1850}$ part of its weight owing to the sun's radiation. If the size of the particle is diminished, the loss becomes comparatively greater, since the volume decreases more rapidly than the surface. Thus the weight of a cube of 10^{-4} cm. side is exactly balanced by the repulsion due to the radiation, and a particle of half that diameter would be given such a velocity of repulsion that it would describe a path equal to the sun's diameter in one hour. The author applies this theory with great success to the formation of the tails of comets. Their curvature would be due to the variation in the incident radiation, and in the size of the particles repelled. He also proposes to apply this theory to the aurora.—S. Arrhenius, Physik. Zeitschr., November 10, 1900.

NATURE OF ROENTGEN RAYS.—In a paper distinguished rather for its boldness of suggestion than its accuracy, W. Rollins criticises the corpuscular theory of cathode rays and the impulse theory of Roentgen rays. He advances two arguments against the supposition that the cathode stream particles are always of the same size, move with the same speed, and carry the same charge. When the cathode in a good X-ray tube is covered with mercury, the X-rays are reduced in intensity, but the whole tube is filled with brilliant white light. The author supposes that the mercury particles constituting the cathode rays are heavier than other metallic particles, and that, therefore, their velocity on striking the target is not sufficiently great to produce X-rays. The latter are regarded by the author as due to radiation from the impinging particles of the nature of heat radiation. Another argument put forward against the electron theory is that if the particles were always the same, the loss of weight of a cathode for any given quantity of electricity discharged should be the same whatever the material of the cathode. And that is not the case. Further, the cessation of X-rays at a certain exhaustion receives no probable explanation by the electron theory.—W. Rollins, Am. Jour. Science, November, 1900.

LIMITING DEFLECTION OF A QUADRANT ELECTROMETER.—In measuring high potentials with the quadrant electrometer, whose sensitiveness is reduced by the employment of a heavy needle and a considerable distance between the wires of the bifilar suspension, it is found that after a certain difference of potential the sensitiveness decreases rapidly, and that the deflection attains a value beyond which it cannot go. A. B. Chauveau points out that the existence of this limiting deviation is due to the impossibility of practically realizing a perfect symmetry of the system formed by the quadrants and the needle, and to the existence of a disturbing electric couple which is proportional to the square of the difference of potential between the quadrants. The author studies theoretically and practically the influence of various modifications of the suspension upon the limiting deflection, and shows that, by a careful construction, the limit can be pushed back almost indefinitely, so that the deflections in one direction at all events should show no serious falling off in the sensitiveness for the higher E.M.F. With his own instrument, which is now installed for use at the Eiffel Tower Observatory, he has thus succeeded in measuring voltages as high as 2,000 or even higher.—A. B. Chauveau, Jour. de Phys., October, 1900.

* Compiled by E. E. Fournier d'Albe, in The Electrician.

THE ORIGIN AND PROGRESS OF SCIENTIFIC SOCIETIES.*

ON the present occasion I propose to say a few words on a subject of little practical importance, so far as the needs of every-day life are concerned, but still not without some general interest, and not without a direct bearing on the history of the advancement of human knowledge—the "Origin, Development, and Aims of our Scientific Societies." The subject is a large one, and it will be impossible to enter into details with regard to its almost innumerable ramifications. In justification of a considerable degree of limitation, I may incidentally mention that the "Official Year-book of the Scientific and Learned Societies of Great Britain and Ireland," for the year 1900, extends over upward of 290 octavo pages.

In England, no learned society received a Royal Charter before 1663, when the Royal Society was incorporated by Charles II. It had, however, been instituted in 1660. So early, moreover, as 1645 the lovers of experimental philosophy formed a society which met weekly in London on a certain day to treat and discourse of philosophical affairs, and many of its members became subsequently the first Fellows of the Royal Society. About the year 1648–1649, this little band of students was divided into two—one part remaining in London and the other migrating to Oxford, where a Philosophical Society of Oxford was established that subsequently for some time worked in concert with the Royal Society, and did not finally cease to exist until 1690.

About the year 1572, "divers gentlemen of London, studious in antiquities, formed themselves into a College or Society of Antiquaries." The honor of this foundation is "entirely due to that munificent patron of letters and learned men, Archbishop Parker. The members met near 20 years at the house of Sir Robert Cotton, and, in 1589, resolved to apply to the Queen for a charter of incorporation, and for some public building, where they might assemble and have a library." A petition was prepared for presentation to Her Majesty Queen Elizabeth praying for the incorporation of "An Academy for the Studye of Antiquity and History," the meetings of which were to be held in the Savoy, or the dissolved Priory of St. John of Jerusalem, or elsewhere. It is uncertain whether this petition was ever presented, but the Queen seems to have given the society her countenance, and under the presidency of Archbishops Parker and Whitgift successively it flourished, and a list of thirty-eight of its members, comprising such well-known names as Camden, Cotton, Erdeswicke, Lambarde, and Stow, is still extant. For some cause or other Elizabeth's successor, James I., thought fit to dissolve the society in 1604, and though attempts were made to revive it in 1617, and though there was an Antiquaries' feast on July 2, 1659, the society remained in a dormant condition until 1707. It then held weekly meetings at the "Bear Tavern," in the Strand, and afterward at the "Young Devil

* Abridgment of an address delivered at the opening meeting of the Society of Arts, November 21, by Sir John Evans, K.C.B., F.R.S.—Nature.

Tavern," in Fleet Street, subsequently moving to the "Fountain Tavern." In 1718, the society was reconstituted, and in 1751 a Charter of Incorporation was granted to it by George II., who declared himself the founder and patron of the Society of Antiquaries of London.

Having traced the inception of the two oldest of our learned societies, which in their early stages partook more of the nature of clubs than of what are now known as societies, I propose, before considering their further developments, to say something as to the proper aims and objects of a learned society, and the means usually adopted for carrying them into effect. Such a society is an association of persons united together by common tastes and anxious to improve or extend some particular branch of knowledge, or even the whole range of scientific inquiry. With this object in view, it becomes necessary to hold periodical meetings for the discussion of subjects in which the society is interested, and for taking such action in respect of them as may seem desirable. The holding of such meetings involves an organization and the appointment of presidents to take the chair at meetings, of secretaries to summon them, and of a treasurer to receive those subscriptions without which an association of the kind cannot exist. Moreover, for the determination of questions of policy and finance, especially when the society issued publications, a council of some kind becomes a necessity. It is on this organization that the success or failure of a society mainly depends; and the questions as to the length of period that presidents and others should remain in office, what proportion of new blood should be infused into the council each year, and how far those in power are carrying out the views of the bulk of the members of the society, have frequently been discussed with more or less warmth. In some instances the too conservative apathy of the council has led to disruption and the foundation of new societies, or to the society under their charge being reduced to a state of inanimate slumber, while on the other hand too rapid revolutionary measures have led to diminutions in numbers, if not to absolute rebellion. Much, of course, of the welfare of a society depends upon the character of its publications being kept at a high level, and on their being brought out with scrupulous regularity.

There is one condition in the life of a scientific society which is entirely beyond its control or that of its council, and this condition may be superinduced by the activity of the society itself. As researches proceed and knowledge extends, new branches of inquiry are opened, which can only be investigated by those who apply themselves specially to the subject. New publications are required, particular days have to be set apart for the discussion of the new subject, and eventually it is found desirable to establish a separate branch of the old society, or to constitute a new one. The latter course is one that has been most often adopted, especially in the case of biological science; and not infrequently the new society finds a home in the apartments of the parent society, and under its fostering care.

Let us now go back to the period when Charles II. granted his second Charter to the Royal Society of London for improving natural knowledge. The Society of Antiquaries was in abeyance, so that the Royal Society was practically the only institution of the kind in Britain, and its aims were naturally wide. On November 20, 1663, the society consisted of 131 Fellows, of whom 18 were noblemen, 22 baronets and knights, 47 esquires, 32 doctors, 2 bachelors of divinity, 2 masters of arts, and 8 strangers or foreign members. With the exception of the large proportion of physicians or doctors, it will be observed that the society in the main was composed of noblemen and gentlemen of independent position, and that the professional element was to a very great extent wanting. Great attention was paid to experimental methods; but "what the learned and inquisitive are doing, or have done in physick, mechanicks, opticks, astronomy, medicine, chymistry, anatomy, both abroad and at home," were subjects on which they were solicitous. Many of the branches of science diligently pursued at the present day were either unknown or in their infancy. The variation of the compass had been observed, but magnetism and electricity presented almost untrodden fields; the steam engine was in an embryonic stage: visions of space with four or more dimensions had not visited the poetical mathematical brain; microscopes and telescopes were in their infancy; the family of the planets was no more numerous than of old; the circulation of the blood had not met with universal acceptance, and the existence of bacilli was but dimly conceived; chemistry was of the crudest, and the elements were earth, air, fire and water; anatomy had already made notable advances, but Dermatological, Laryngological, and Odontological societies were not even dreamt of; geology was unborn, and palæontology did not exist, except in connection with Noah's Deluge.

One of the results of this very wide scope of the Royal Society was that at its meetings the variety of subjects brought forward for discussion was great; and the early volumes of the Philosophical Transactions contain a large amount of miscellaneous reading. I am not sure that, as a means of whiling away a spare half hour, one of the first twenty volumes of the Transactions would not by most persons be found more attractive and amusing than the volume, say, of Series A for the year 1900.

The Society for the Encouragement of Arts, Manufactures, and Commerce was founded in 1754, but not incorporated until 1847, and this society, together with the two already mentioned, form the trio from which nearly all the numerous learned societies of the present day have sprung, by what may be regarded as a natural process of evolution.

As might have been expected, Scotland was not long in following the example set by England, and the Medical Society of Edinburgh was instituted in 1734, to be followed by the somewhat kindred Harveian Society in 1752. In the meantime, the Royal Society of Edinburgh, or, as it was originally called, the Philosophical Society, was established in 1739. The "Royal Physical Society of Edinburgh," exclusively devoted to "Natural History and the Physical Sciences," was founded in 1771, and by 1813 had absorbed no less than six other societies, which became incorporated in it.

In Ireland, the Royal Irish Academy for "the study of Science, Polite Literature, and Antiquities," was founded in 1785, and may be regarded as combining the attributes of the three parent societies in London.

Among the off-shoots of the Royal Society of London, the first perhaps is the Medical Society, founded in 1773. The Linnean Society, for the cultivation of natural history in all its branches, was founded in 1788, and has from 700 to 800 Fellows. These are the only two London societies coming under this category that date from the last century.

During the century now drawing to its close, the vast advances in science, and the innumerable aspects it assumes, has led to the foundation of numerous scientific societies, each with a more or less limited scope. In natural history we have the Horticultural (1804), the Zoological (1826), the Entomological (1833), the Ornithological (1837), the Royal Botanic (1839), the Ray Society (1844), the Palæontographical (1847), and others that it would be tedious to mention.

Geology as a new science had a society founded for its study in 1807, the Geologists' Association followed in 1858, and at a later date the Mineralogical Society (1876). The Royal Astronomical Society (1820) has been supplemented by the British Astronomical Association. Mathematics and Physics have also their own societies, as has also Statistics, a subject which has a mathematical side as well as one in the direction of commerce and the affairs of ordinary life. Engineering is represented, not only by the Institution of Civil Engineers (1818), but by the Institution of Mechanical Engineers (1847), of Mining Engineers (1851), the Iron and Steel Institute (1869), and that of Electrical Engineers (1871). Geography has had its own Royal Society since 1830, Microscopy its society since 1839, and Meteorology since 1850. For medicine, pharmaceutics, pathology, neurology, anatomy, and some other branches of medical inquiry, special societies have been founded in London. The Victoria Institute or Philosophical Society of Great Britain was founded in 1865, its primary object being the attempt to reconcile apparent discrepancies between Christianity and science.

In Edinburgh and Dublin scientific societies have multiplied, though not to a similar extent; and throughout the United Kingdom there are numerous literary and philosophical societies, that of Manchester dating back to 1781. There are also several provincial geological societies, and almost every county has its natural history society or club.

Moreover, the British Association for the Advancement of Science, founded in 1831, continues to hold its annual meetings at different centers in the empire, and helps to maintain the general interest in the advancement of knowledge and to kindle or keep alive local zeal.

The offshoots from the Society of Antiquaries have not been so numerous or important as those from the Royal Society, the field of Archæology being much more restricted than the wide domain of more purely "natural knowledge." The Society of Antiquaries of Scotland dates, however, from 1780, and that of Newcastle-on-Tyne from 1813, while the Literary and Antiquarian Society of Perth goes back to 1784. Several branches of antiquarian study have now their own societies. The Numismatic Society was founded in 1836, the Royal Historical Society in 1868, the Society of Biblical Archæology in 1871, the Palæontographical in 1873, and that for Hellenic studies in 1879. There are also special societies for the exploration of Palestine and Egypt, as well as the important Royal Asiatic Society with its different branches. The peripatetic habits of the Royal Archæological Institute and of the British Archæological Association (both 1843) help to maintain the warmth of local interest and to disseminate a certain amount of archæological information.

Anthropology and ethnology have made great advance since the foundation of the Ethnological Society in 1843, and of the Anthropological in 1863. The two merged in 1871 to form the Anthropological Institute, which has rendered signal services to science. A minor branch of anthropology—Folk Lore—has had its own society at work since 1878.

The Society of Arts—to make use of its shortened title—can claim nearly as numerous an offspring as its elder sisters, the Royal Society and the Society of Antiquaries. Her descendants, moreover, are fairly entitled to as high, if not indeed a higher, rank and importance. It is not merely the Royal Scottish Society of Arts (1821) that she can claim as an offshoot, but it was the Society of Arts that first in England devoted attention to the all-important objects of forestry and agriculture. The Royal Agricultural Society originated not earlier than 1838, though in Scotland a Society of Improvers of Agriculture was instituted in 1723, a Dublin Agricultural Society in 1731, the Bath and West of England Society in 1777, and the Highland Society in 1784.

It would, moreover, be unfair not to credit the Society of Arts, as well as the Royal Society, with having laid the foundations on which the Institution of Civil Engineers and the cognate bodies have been erected. The Chemical Society was established at a meeting held at the rooms of the Society of Arts, in 1841. From this arose the Institute of Chemistry, in 1877. The Society of Chemical Industry (1881) to a large extent grew out of the Chemical Section of the Society of Arts, which dealt for some years with the chemical industries, and was dropped on the foundation of the society. The Sanitary Institute and the other sanitary societies certainly owe their origin to the Conferences on the Health and Sewage of Towns held by the Society of Arts in 1877, 1879, and 1880. The City and Guilds' Institute also originated in consequence of the action of the society in the matter of technical education. They took up and carried on the technological examination founded by the Society of Arts.

It must never be forgotten that in its earlier days inventions of all useful kinds, and all that was new in machinery and manufactures, came within the scope of the society, which in thirty years spent many thousands of pounds in rewards and premiums for useful inventions.

It took a very active part in all educational movements and a warm interest in the welfare of our colonies, and to its credit be it said that the examinations of the Society of Arts still rank among the most useful and thorough, while the existence of our Indian Section still evinces our interest in the prosperity of the dependencies of the empire.

What the society has done for the advancement of art, it is difficult for us of the present day fully to appreciate; but it must be remembered that one of the first, if not, indeed, the first public exhibition of pictures was that held in the society's rooms in 1760, and that from this exhibition sprang the Royal Academy, the first exhibition of which, comprising one hundred and thirty-six works only, was opened in 1769. We may, therefore, here claim the Royal Academy as in a certain sense an offshoot from our body. The Royal Institute of British Architects, founded in 1835, may also in some degree be regarded as connected with the Royal Academy, which admits architects among its members. The Photographic Society also grew out of an exhibition of photographs, the first of the kind held in our rooms. The foundation of the Royal College of Music is likewise due to the exertions of the Society of Arts.

It would, indeed, be difficult to say how far the work done by any society would have been accomplished by the individuals composing that society, without combination or collective organization. A society, of course, is only a collection of individuals, and the work of the society is the work of the individuals composing it.

A society offers opportunities for discussion, brings men of similar ideas together, and substitutes collective and organized action for isolated individual effort. It affords means of publication, organizes research, records discoveries, stimulates invention, and assists students by providing a common meeting place and center of action. Every scientific discoverer desires immediate publication of his work, both for his own reputation and to secure the assistance of his colleagues. Every industrial inventor requires publication in order that he may secure the natural profits of his invention. A society systematizes and arranges the science of study which is its subject-matter.

The present condition of science is certainly due to the organized efforts of such societies as the Royal Society and its subordinate societies in this and other countries. They secure public recognition for science and those who pursue it; they prevent overlapping; serve to deter different men from working on the same lines; and they bring influence to bear on the public and on the government. Any individual is less powerful by himself than when he is associated with others seeking the same object. An active society is a corporation with a perpetual succession, and it never dies. The work carried on by an isolated student ceases at his death, but the work done by a number of students associated together goes on and on. As one man drops out, another takes his place.

An excellent example of the reciprocal influence of scientific workers and of a scientific institution upon each other is afforded by the Royal Institution. Without Davy, Faraday, or Tyndall, the Royal Institution would never have become the important body it now is. But without the Royal Institution neither Davy nor Faraday would have had an opportunity for carrying out their scientific work and of obtaining their scientific reputation, and perhaps the same may be said to a certain extent of Dr. Tyndall.

The history that I have been tracing comprises within it a record of the advance in many directions of our acquaintance with the secrets of nature, of our turning that acquaintance to practical account, and of the consequent progress of the nation in material prosperity. It bears witness likewise to that specialization in science which, though by no means an unmixed blessing, seems to be of necessity associated with all advancement in natural knowledge. The days are long since past when any single individual could attempt to cope with the whole encyclopædia of science; but the question not unfrequently arises at the present day whether the position of the specialist would not be more secure were the foundations on which he builds extended over a larger area, and were his scientific sympathies somewhat wider in their character.

Another question that may be asked is whether there is any need for this multiplicity of societies. The answer from any one who in whatever manner believes in evolution will be that at the time of founding each society a necessity for it must at all events have been thought to exist, and that the analogous societies at that time in being must have been either unable or unwilling to adjust or expand themselves so as to include the subject for the study of which the new society was instituted. Many of the subjects, for instance, that originally came within the domain of the Royal Society, and indeed are still included within it, have by degrees been not absolutely banished from it, but relegated in the main to other societies, founded more especially for the study and illustration of such subjects. The Linnean, the Astronomical, the Chemical, and the Geological Societies afford instances in point, and any attempt to suppress such societies, and to bring their members all within the fold of the Royal Society, would have a disastrous effect on the advance of science, and would absolutely overweight the powers of the Royal Society itself. At the same time it must be remembered that accounts of important discoveries in any of these branches of knowledge are cordially welcomed by the Royal Society, and that it is usually the case that the leading Fellows of these special societies are also Fellows of the Royal Society. The same in a lesser degree holds good with the Society of Antiquaries, as archæological discoveries, especially when bearing on the early history of man, are welcomed alike on both sides of the quadrangle at Burlington House.

Turning to the more purely philosophical societies that have been established in London, it would seem as if for some reason or other the soil was not congenial for their growth or longevity. The Dialectical Society, founded in 1865, was dissolved in 1888; the Psychological, founded in 1875, ceased to exist in 1879, but was resuscitated under the name of the Society for Psychical Research in 1882. The Zetetical Society, established in 1879, and the Aristotelian in 1880, do not appear in Whitaker's List of Societies and Institutions, though the latter, notwithstanding that its members are few, is still in active operation. Altogether, the number of those interested in abstract philosophy seems to bear no proportion to that of the votaries of the study of nature in all its phases and of those who devote themselves to the application of science to the good of mankind.

In the Institut de France, one of the Académies is that of Sciences Morales et Politiques, which, however,

is divided into five sections. Of the eight places devoted to philosophy, only six were filled at the beginning of the present year, but this may have been purely accidental. The mention of the Institut suggests the question how far a similar association of academies would meet the requirements of this country. Such a question is beyond the limits of the present address, but in passing I may say that the necessary limitations of the Institut, the payment for attendance, the method of election of its members, and its close connection with the government of the day, all present features which are hardly in accordance with our insular traditions. In Paris itself the Institut has had to be supplemented by various important scientific societies, such, for instance, as the Geological Society and the Society of Antiquaries of France.

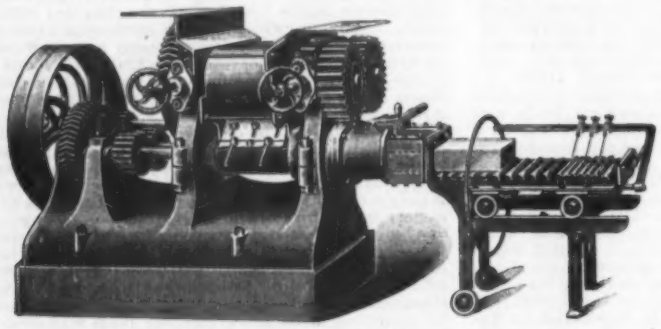


FIG. 10.--BRICKMAKING MACHINE CONSTRUCTED BY MM. BOULET, BLOIS.

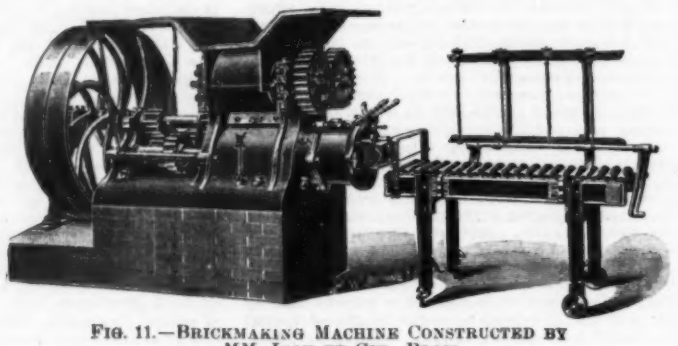


FIG. 11.—BRICKMAKING MACHINE CONSTRUCTED BY MM. JOLY ET CIE., BLOIS.

[Continued from SUPPLEMENT, No. 1302, page 20867.]

CLAY-WORKING MACHINERY AT THE PARIS EXPOSITION.

A NUMBER of examples of continuous brick-making machines are shown; in this type the clay is forced through a die at the bottom of a pug mill, and received on a traveling table. The dimensions of the die correspond to those of the brick, and the clay as it issues is cut into the desired size by a suitable device. The receiver may constitute a pugging mill, and drive the clay forward by a screw, or the clay previously prepared may be forced through the die by the pressure of a plunger in the cylinder. This class of machine, as usually made in France, consists of a heavy frame carrying a horizontal cylinder, in which, driven by gearing, are two screw shafts turning in opposite directions. The clay previously prepared is fed into the top of the cylinder through a hopper at one end. At the other end of the cylinder is attached the die, made of brass or steel; this die is movable, so that it can be easily replaced, when different products are to be made. The prism of clay (when bricks are being manufactured) issues slowly through the die on to a series of rollers constituting the table; to this table is hinged a cutting device consisting of a frame, to which wires are stretched. The to-and-fro movement of this frame, which is worked by hand, passes the wires through the clay, completing the bricks, which are then taken off the table by hand for kilning. There are many machines of this type at the Exhibition; that shown by Boulet, of Blois, is a good example (see Fig. 10). In this, the clay is fed into the cylinder through a pair of crushing rollers. The figure explains the complete installation, and shows the mode of gearing the rollers, and the screws within the cylinder. From 2 to 8 horse power are required to drive this machine, which turns out 700 to 1,500 bricks an hour. MM. Joly, of Blois, show machines very similar to that illustrated in Fig. 10, though, perhaps, of a somewhat lighter design, and differing in the construction of the die (Fig. 11). Fig. 12 a brickmaking machine shown by the Delahayes firm, is very similar, but it is provided with two pairs of rolls above the cylinder, so that the clay can be more thoroughly treated before passing through the die. The prices of these machines range from £80 to £100, including the cutting table and one set of dies. Other exhibitors of similar machines are MM. Lacroix, Pinette, etc. The German clayworking exhibit is that of Schlickeysen, of Berlin; it is placed in the German annex on the Champ de Mars, Avenue Suffren side, and calls for special mention. The leading idea of horizontal cylinder and double feeding screw is the same, but they are provided with multiple dies; one machine shown has four, so that with the same machine and at the same time different products can be produced. Thus solid bricks, hollow bricks, flat tiles and moulded tiles are made simultaneously at the Exhibition. Fig. 14 illustrates one of these machines; it will be seen that the installation is a very complete one. The clay is raised by the endless chain of buckets and delivered into the hopper, whence it flows through the crushing rolls into the feeding cylinder. This is provided (in the example illustrated) with two lateral and one end die, but, of course, one only, or two of these, need be used if desired. The advantage of the system is evidently an increased output, and it is reliably stated that the quality is equally good. It should be noted that the Schlickeysen machine is provided with a safety device by which the driving pulley is thrown off if a stone or other hard body passes to the rollers with the clay; danger of breakage is thereby avoided.

The American Clay-Working Machinery Company, of Bucyrus, to whose exhibit reference has already been made, show a machine of the continuous type, and called the "Giant Auger Machine;" this is illustrated in Fig. 13, from which it will be seen the principle is identical, though details are different, and the

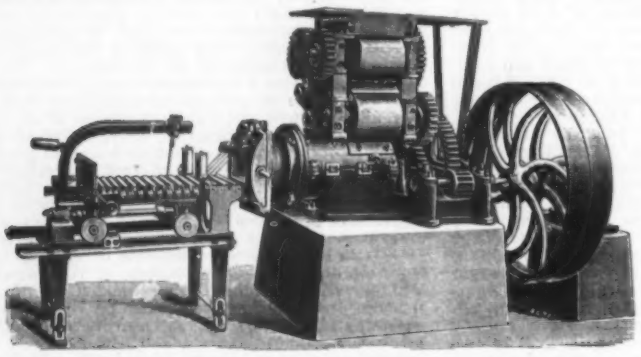


FIG. 12.—BRICKMAKING MACHINE CONSTRUCTED BY MM. DELAHAYES, TOURS.

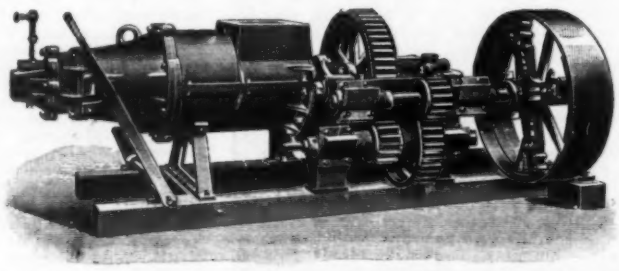


FIG. 13.—BRICKMAKING MACHINE CONSTRUCTED BY THE AMERICAN CLAY WORKING MACHINERY COMPANY, BUCYRUS, OHIO, U. S. A.

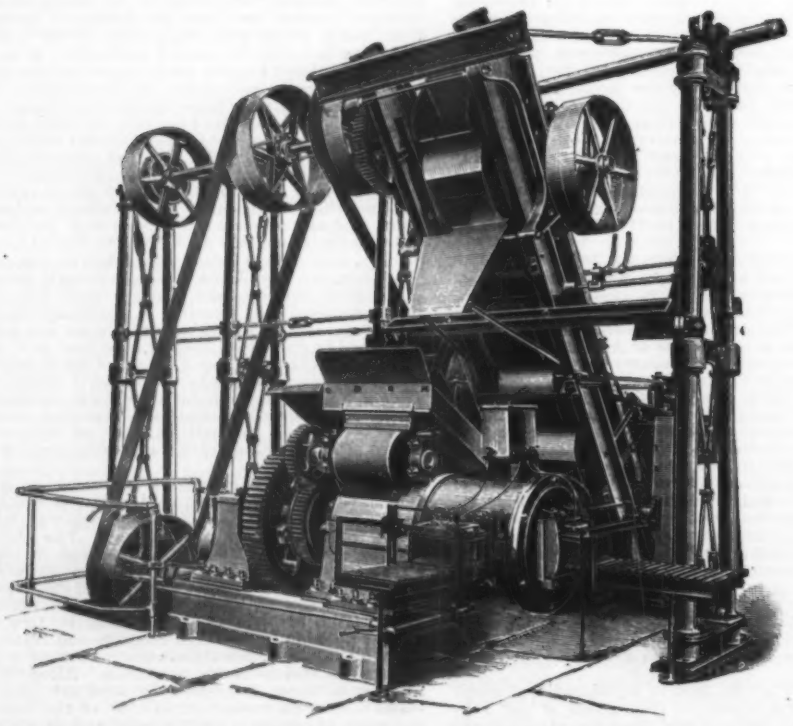
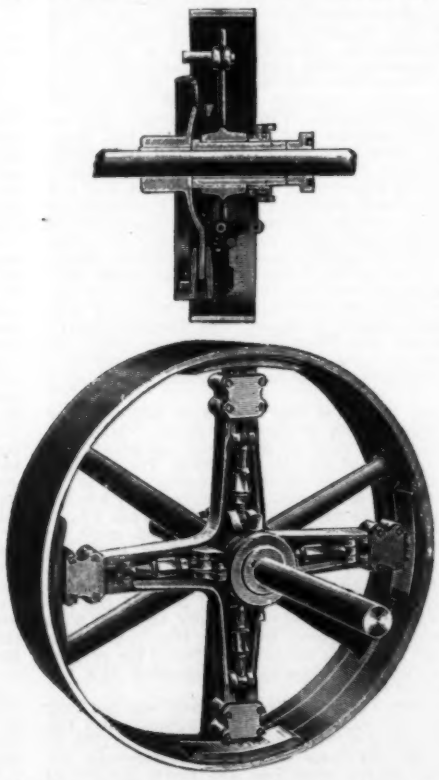


FIG. 14.—BRICKMAKING MACHINE CONSTRUCTED BY HERR SCHLICKEYSEN, BERLIN.



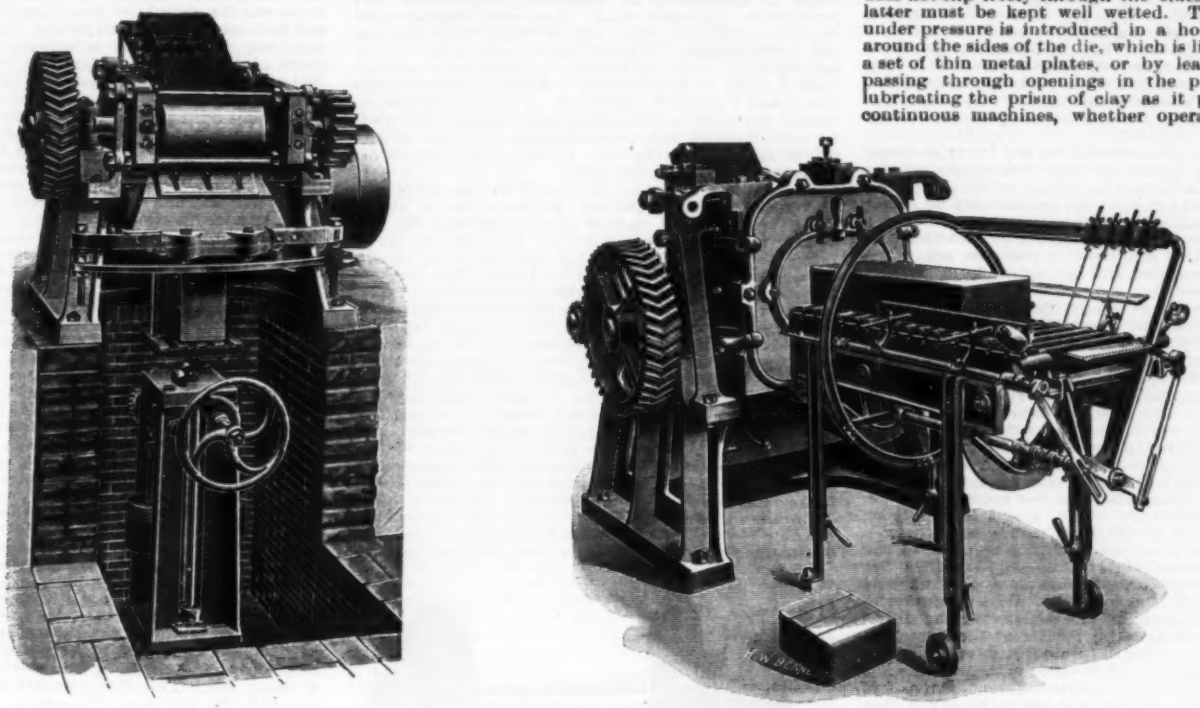
FIGS. 15 AND 16.—FOUR-ARMED FRICTION CLUTCH CONSTRUCTED BY THE AMERICAN CLAY-WORKING MACHINERY COMPANY, BUCYRUS, OHIO, U. S. A.

machine is specially designed for working with hard, not very plastic clay. The larger sizes have a capacity of 5,000 to 10,000 bricks an hour; but the example shown in Paris is smaller, and has an output of 2,500 to 5,000. Of course, the power required to drive is proportionately greater for the larger sizes, being from 50 to 60 horse power. The machine is driven through a friction clutch pulley, shown separately in Figs. 15 and 16, which show a four-armed device that can be thrown in or out of contact with the inside of the pulley rim, by means of a lever shown in Fig. 13; when out of gear the pulley runs loose. The clutch consists of four arms fast on the main shaft, and each carrying at the end a rubber-covered block which, through the agency of springs, can be withdrawn or forced against the pulley by the lever before mentioned. The device for cutting the clay as it flows through the die is automatic, and it should be mentioned that ingenious fittings are applied to the die to make moulded bricks.

It sometimes happens, from the quality of the clay, or for other reasons, that the cylinder with the screw feed is not desirable, and the plunger type of machine is preferred. Essentially this consists of a cylinder with one of smaller diameter within it. The clay is fed into the larger cylinder, and the smaller one being forced down presses the clay through the annular space and through a die placed in the side of the larger cylinder. Machines of this type are shown by MM. Joly, of Blois. Fig. 17 shows such a machine arranged for the manufacture of ordinary products, solid and hollow bricks, etc. But with a special arrangement it can be very quickly converted into a vertical machine, as shown in Fig. 18; it is thus specially adapted for making drain pipes, and any form of pottery that can be produced through a die. When used in this way it has to be mounted over a pit, in which is placed a balanced receiving table. This machine has a capacity of about 1,500 bricks an hour. It costs £124, and requires 3 to 4 horse power to drive it. The construction is very strong.

When making bricks by machines of this type, Fig. 12, etc., it is generally necessary to work the clay thoroughly before feeding it into the cylinder, and for this purpose any of the pug mills already described are suitable, the clay passing, if desired, direct from one machine into the other. A combined installation of this class is exhibited by MM. Chambrette-Belon. The die with which the machine is fitted delivers the clay continuously, but has a special construction. According to the constructors, when the clay is poor, and does not slip freely through the sides of the die, the latter must be kept well wetted. To do this, water under pressure is introduced in a hollow space found around the sides of the die, which is lined to shape by a set of thin metal plates, or by leather, the water passing through openings in the plates or leather, lubricating the prism of clay as it passes out. The continuous machines, whether operated by feeding screws or plungers, are adapted to make bricks of all sizes, as well as blanks for tiles. For the latter a special cutting device is necessary, and it may be remarked here that all the cutting tables on the French machines shown are worked by hand.

A few words may be added on the arrangement of cutting tables exhibited, which, as we just said, are operated by hand. Fig. 19 is a cutting table for tiles, shown by MM. Joly. When the prism of soft clay reaches the end of the table, the swinging frame carry-



FIGS. 17 AND 18.—PLUNGER BRICK AND TILE MACHINE CONSTRUCTED BY MM. JOLY ET CIE., BLOIS.

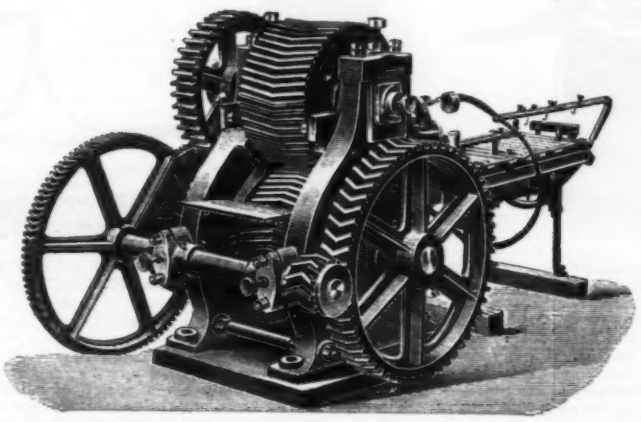


FIG. 19.—CUTTING TABLE FOR TILES CONSTRUCTED BY MM. JOLY ET CIE., BLOIS.

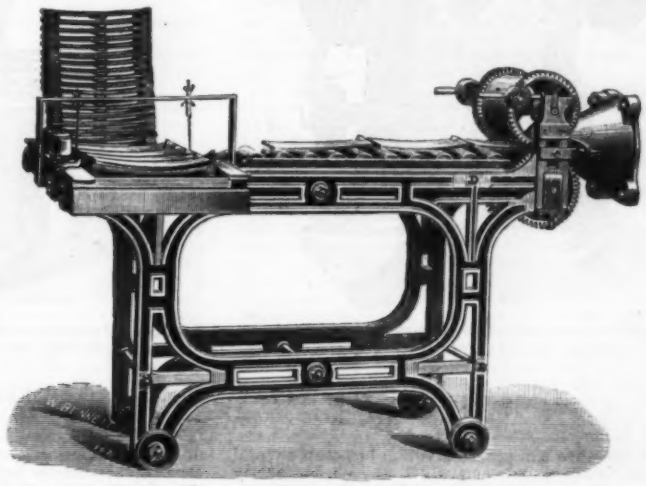


FIG. 20.—BRICK-CUTTING TABLE CONSTRUCTED BY MM. JOLY ET CIE., BLOIS.

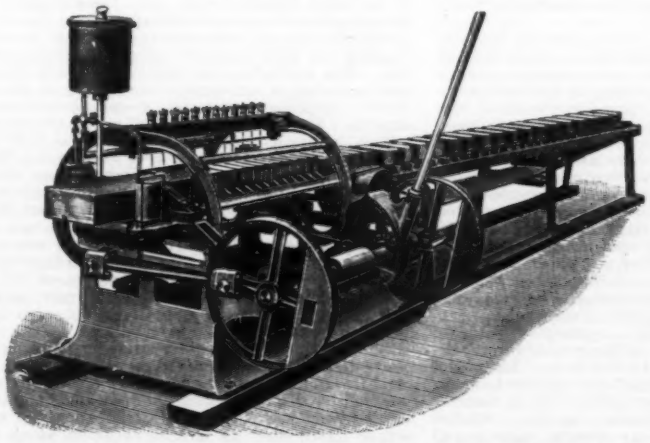


FIG. 21.—AUTOMATIC BRICK-CUTTING TABLE CONSTRUCTED BY THE AMERICAN CLAY-WORKING MACHINERY COMPANY, BUCYRUS, OHIO, U. S. A.

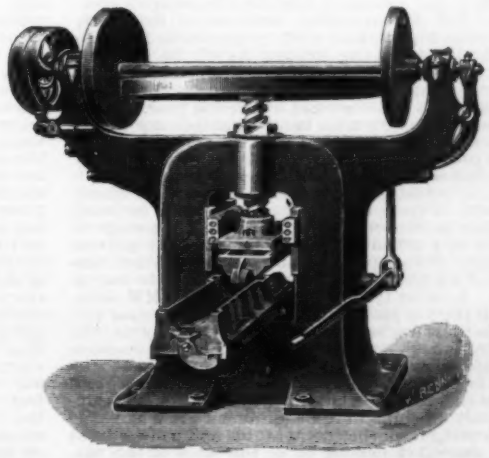


FIG. 22.—TILE PRESS CONSTRUCTED BY MM. BOULET ET CIE., PARIS.

CLAY-WORKING MACHINERY AT THE PARIS EXPOSITION.

ing the wires is brought down sharply and then raised, the wires passing through the cuts made in the down stroke. A little practice enables the workman to do this easily. Another cutting device by the same exhibitors is so arranged that the blanks pass between embossed cylinders, and are delivered finished (see Fig. 20). In another arrangement the cutting wires can work in either direction, so that the cut can be made upward or downward, indifferently.

The American machine to which we have already referred is supplied with an automatic cutting device, which is illustrated in Fig. 21. The oscillating wire frame is driven by gearing from the machine itself, the speeds being so regulated that the passage of the wires through the clay does not affect the form of the bricks. The distance between the wires is easily regulated, so that slabs of any thickness can be cut. As the bricks leave the table, they are carried away on an endless traveling belt.

The tile blanks just referred to are brought direct to the tilemaking machines, which are simply presses with dies of various kinds, according to the pattern of tile to be produced; the moulds or dies may be either of plaster or steel, according to whether the clay is hard or soft. The blank being placed between the dies, it is exposed to considerable pressure, and is removed much compressed and having the form and design of the finished tile.

The tile presses are generally operated by a screw. MM. Boulet & Company show some examples of this type, illustrated by Fig. 22. Others are on the system exhibited by Pinette & Company. In this the lower mould is repeated on the five faces of a revolving block, Fig. 23, caused to turn intermittently by the gearing shown. A clay blank is placed on the inclined face of the mould, which then turns through one-fifth of a revolution, bringing the blank into a horizontal position under the upper mould, which is mounted at the end of a rising and falling crosshead, the relative movement being so adjusted that the upper mould descends on the stationary blank, and forms the tile; the revolving lower mould then makes one-fifth of a turn, the stamped tile is removed from one side of the machine, a new blank is laid on the mould on the other side, and the operations are repeated. Such a machine as this produces 500 tiles an hour. MM. Chambrette-Belon exhibit a machine of this class, with the difference that the upper mould is fixed, and the lower one rises and falls, revolving intermittently, of course, as in the Pinette machine. It is obvious that the moulds can be changed, so as to produce different patterns of tiles. In all these machines care has to be taken that the total pressure exerted is divided between several distinct movements, between which the clay is partly raised from the moulds in order to free it from air.

Belonging to the same branch of this industry are the machines for making small flat tiles for paving, etc. But to obtain a sufficiently compact and regular product, a firm clay should be used, and thoroughly compressed. MM. Boulet exhibit machines of this class, illustrated in Fig. 24, and which is applicable for making hard tiles and facing bricks. As will be seen, the table of this press has three moulds, which are passed successively under the rising and falling plunger that is operated by a screw worked by friction gear.

For second quality tiles, hand machines are chiefly used, an ordinary type being that shown in Fig. 25, a Brethin press, made and exhibited in various sizes by the Delahayes Company. This press is largely used in France; it consists of a heavy cast-iron vertical frame, and a table of wood, the whole machine being mounted on wheels as shown. Without detailed drawings it would be very difficult clearly to explain the ingenious mechanism of this press; that it is an excellent machine for its purpose is proved by its wide use in France. Another type of press is shown by MM. Joly, in which the top piece is fixed and the mould rises and falls, the pressure being exerted on the clay in the mould by knuckle-jointed levers. The largest machine of this kind is the heavy power press shown by the Clay-Working Machinery Company, of Bucyrus, and which is able to treat a large quantity. It forms a supplementary machine to the continuous brick mill, the bricks coming from the cutting table and endless band already described, passing on to the table of this machine and into the moulds, two being pressed at each operation; the pressed bricks are then passed on to the delivery table. The various processes of the machine are automatic.—Engineering.

(To be continued.)

FIG. 23.—TILE PRESS CONSTRUCTED BY M. G. PINETTE, CHALONS-SUR-SAONE.

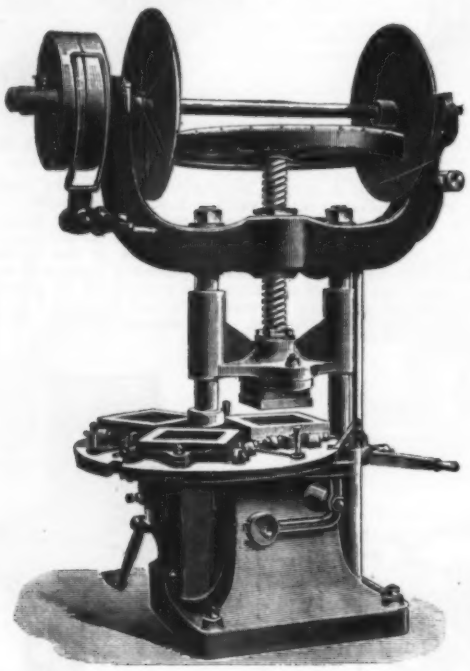


FIG. 24.—MACHINE FOR PAVING TILES CONSTRUCTED BY MM. BOULET ET CIE., PARIS.

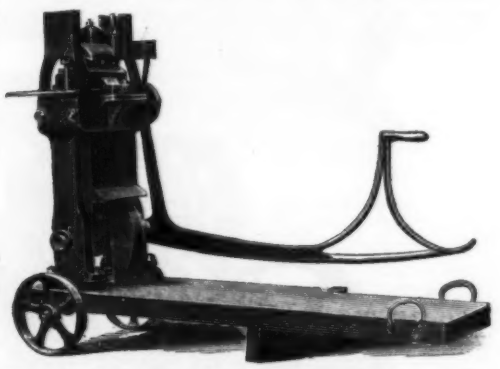


FIG. 25.—BRETHIN HAND TILE PRESS CONSTRUCTED BY MM. DELAHAYES, TOURS.

CLAY-WORKING MACHINERY AT THE PARIS EXPOSITION.

[Continued from SUPPLEMENT, No. 1302, page 20673.]

THE PARIS EXPOSITION OF 1900.*

By CARL HERING.

IN electric railroading there seemed to be comparatively little of special interest to Americans, besides the three-phase motor system and the contact bar, already referred to, both of which deserve more attention here than they are getting. The new Metropolitan underground electric road quite recently opened in Paris is apparently an excellently constructed but wretchedly managed road. American management would diminish the total time of transit and increase the profits greatly. It is an improvement over the new underground road in London in that motor cars are used instead of locomotives, but being directly under the street instead of very deep, as in London, the excellent device of a descending and an ascending grade between stations, to aid acceleration and stopping, cannot be taken advantage of. Both of these roads use American electrical machinery.

The two new electrically operated extensions of several steam railroads into the central parts of Paris; the new and much needed electric railroad to Versailles; and the new conduit road in Paris, are all of interest. A surface contact line and one using accumulators are also being tried in Paris. The Western Railroad, one of the largest steam railroads of France, is making very extensive preparations toward introducing electric traction on its lines by more improved methods than its Heilman locomotives. If our steam railroads were as enterprising, the replacing of steam by electric traction would progress more rapidly here. Through the kindness of Mr. Cleranlt, the chief engineer of this enterprising steam railroad, our Institute had the pleasure of accepting an invitation for a personally conducted visit to its interesting plant. It has already in operation in part a large three-phase power station near Paris, accompanied by extensive laboratories; has constructed an electrical extension of its steam lines toward the center of the city; is building the new electric line to Versailles over an excellently constructed and well graded private roadway, and has under construction a number of electric locomotives. Paris is therefore at last beginning to avail herself of the advantages of electricity for traction, and will unquestionably be very greatly benefited thereby. If with this modern traction force a more modern and more American system of managing and operating the city tramways was introduced, the Parisians, the many visitors and the owners of the tramways, would all be the gainers.

In the exhibition itself may be mentioned the two miles of moving platform, which differed from the one in Chicago in that the motors were stationary while the rails moved. The third-rail electric railroad paralleling it, but running in the opposite direction, was virtually an American exhibit and was managed more like American roads, making a refreshing contrast to the wretchedly managed tramways and omnibuses in the city. Both the platform and this railway were fed from two 800 horse power induction motor-generator sets made in this country, the induction motor, started by its mate, being one of the largest ever made. The conduit road which was shown was also virtually one of those developed in this country. A short section of the "suspended" railway was exhibited, but whether this struggle for recognition was successful seems questionable. Another curious departure shown in operation was the trolley automotor, a system of running electrically driven vehicles on ordinary roads, but taking current from an overhead trolley wire. The novel feature was that the small contact carriage running on the two wires was geared electrically to the motors by means of a local three-phase current, so that it tended to travel slightly faster, thereby always leading and keeping the connecting cable taut. A field for it might exist where omnibuses are now used.

A number of large electric locomotives were exhibited, notably one from Berlin, showing that heavy electric traction is making progress. One weighing about 45 tons, exhibited by the French steam railroad known as the P. L. M., was operated with accumulators carried on a tender, but the claims made for it by the attendant were so remarkable that a verification is desirable before they can be considered. Although it was dated 1896, I was told that it was "not yet" in constant use.

In electric lighting, one of the most interesting features was the debut of the Nernst lamp. After long and tedious labors on the part of the General Electric Company, of Berlin, the interesting laboratory experiment of Nernst, that a filament of a non-conductor like magnesia becomes a conductor after it is heated, has been developed into a form of high efficiency incandescent lamp, which is now claimed to be ready for the market; but although several hundred were burning there daily, it was not possible to buy one. It resembles the usual incandescent lamp except that the bulb is open; the filament is somewhat thicker and much shorter than that of a carbon lamp; the light is very much whiter and more brilliant. It can be lighted with a match, alcohol torch or automatically by a platinum wire preheater with a magnetic interrupter. Either alternating or continuous currents can be used, but the filament must be exposed to the air. The lamps are made for 25, 50 and 100 candle power at 220 volts, and therefore do not yet compete directly with the usual 16 candle power lamp. The efficiency is said to be 1·5 watts per candle, or about twice as good as the present carbon lamp of the same voltage. The filament is said to be made of magnesia mixed with the rare earths like zircon, thorium, etc. The life is claimed to be very satisfactory, though no figures could be obtained, but the perishable parts, valued at only 25 per cent. of the probable cost of the lamp, can easily be replaced, the bulb being open.

The material of which the filament is made has a rapidly falling temperature coefficient, much worse than carbon, which would make it extremely sensitive to changes in voltage. This is overcome by a very ingenious method, to which the present success of the lamp is due; it consists in placing a very fine iron wire in series with the filament, the wire being so proportioned that it is heated by the normal current to that temperature (about 450 to 500 degrees C.) at which it has a very rapidly rising temperature coefficient; the resulting characteristic of the two in series is therefore a rising one. This fine wire consumes about 10 per cent. of the voltage. The price of the lamp, it is thought, may be about 50 cents.

Among the novelties in arc lamps which attracted some attention during the few days it was on exhibition was the Bremer lamp in which the carbons contain certain salts, like those of magnesia, together with fluor calcium, that deposits a white oxide on surrounding bodies which acts both as a Nernst conductor and a white reflector, the carbons being inclined like the letter V. A reliable German authority found the efficiency to be 0·13 watt per hemispherical candle power. The light is said to be steady and bright but soft.

The only inclosed arc lamps exhibited were from this country, directly or indirectly. These lamps, which are so largely adopted here, are scarcely known on the Continent, and in France at least it seems that they are not even wanted, on the ground that the light is too blue and unsteady, and the efficiency too low. As manual labor is much cheaper there than here, and arc lamps are not used nearly as much, the chief advantage of this lamp is not appreciated, at least not yet. The arc lights there are, as a rule, much steadier, and are almost universally connected to constant potential circuits, our series system being almost unknown. The general type of regulating mechanism which is in favor is that in which the coil applies a brake to an escapement wheel which tends to revolve by the weight of the descending carbon; the regulation is therefore very sensitive and gradual. Cored carbons of a fine quality are moreover almost universally used. Generally, only two lamps are in series across the usual 110-volt mains, but in some cases as many as three are connected, with an increase in light efficiency; in such cases the lamps are of the differential type, in which the regulating mechanism is actuated not only by a shunt coil but also by one in series.

The exhibits of electric chandeliers and like fixtures were mostly French, and were generally very tasteful, artistic and often very beautiful, although frequently marred by external wiring, as with many of them concealed wiring is impractical. The accessories, on the other hand, such as circuit breakers, small switches, lamp sockets, motor starting resistances, etc., were frequently quite bad or too complicated, from an American standpoint. There would seem to be quite a market abroad for the better classes of American goods of this kind. It is hard to understand why electrically

* Inaugural address by the president at the 147th meeting of the American Institute of Electrical Engineers, New York, October 24, 1900. From the Transactions of the Institute.

started fires are not more frequent on the Continent with such poor appliances of this kind that one finds in use there.

The relatively large number of exhibits of switchboard switches for breaking currents of very high voltage indicates the rapid introduction of high tension currents. In many of them the well-known double horn is used for extinguishing the arc, which is an indication of the effectiveness of this simple device.

A novel departure in switchboards, especially for dangerously high voltage machines, consisted in placing all the switching apparatus belonging to one machine on or under a post or pedestal near the machine itself, and so that the attendant faces the machine. The actual switches are under the floor where they are out of the way and easily accessible from a pit below, only the levers, hand wheels and instruments being on the pedestal; the attendant is thereby protected from all the possible danger. It is the standard practice of the Oerlikon Company.

The use of silver fuse wire in place of lead alloys, by a very large German company, on the ground of greater reliability and constancy, deserves mention. For the same fusing current the amount of metal volatilized is the least for silver.

The non-interchangeable fuses of Siemens and Halske were of some interest and seem to supply a need.

Among the cable exhibits there were three for underground work in which multiple-cored cables were subjected to 25,000 and 30,000 volts alternating, the insulation in one of these being impregnated paper without any rubber.

A German maker of aluminium goods showed that this metal can be welded without solder or flux by simply heating it to a certain definite temperature at which it softens. The use of aluminium line wires makes this simple method of interest to electrical engineers.

The number of different types of meters exhibited was about equal to the number of their exhibitors, but the Thomson meter, in nearly the same form as made in this country, is the one most frequently used; several hundred a day are claimed to be made by the French company which manufactures them. The field for a good cheap and simple ampere-hour meter for small consumers of continuous current is filled very satisfactorily in France by the O'Keenan meter, of which 11,000 are already installed. In principle it may be said to be like a D'Arsonval galvanometer or Weston instrument, in which however the coil is mounted so that it may revolve continuously, the number of its revolutions being registered. This coil or armature is a shunt to a very low resistance in the main circuit. It is extremely sensitive and the coil requires only 0·6 microwatt to start it; it will register as little as 5 watts in the lamp circuit or 1 per cent. of its range, has a straight line characteristic, and is not appreciably affected by temperature changes. A somewhat similar one is about to be introduced in this country, and there is no doubt a large field for it.

The well-known and ingenious Aron double pendulum meter was well exhibited in various forms, including one for three-phase currents. It is said to be used to some extent in Germany, but would probably not find much favor in this country.

An interesting and promising modification in the Thomson type of watt-hour meter, shown in the German section, consisted in using a three-coil armature like that in the original Thomson-Houston arc light machines; this enables the same magnetic force to be produced by a much smaller weight of the revolving part, with several attending advantages of importance.

Prepayment meters are meeting with some favor, and there might also be a field for them in this country among small consumers.

In telegraphy the exhibit which seemed to attract most attention was the very ingenious printing telegraph system of Prof. Henry A. Rowland, of Baltimore. The sender merely presses lettered keys like on a typewriter, and at the other end the message is received in print on a sheet of paper ready for delivery, without requiring any operator. An alternating current of constant frequency is passed over the single line and operates synchronous motors, by means of which the necessary synchronism at the two stations is obtained. The different characters are transmitted by the suppressing of various combinations of the half waves of the current. At the receiver end those waves are received in a large number of relays, various combinations of which operate a few electromagnets for printing the characters and moving the paper laterally and lengthwise. The typewheel revolves continuously, and the paper directly beneath it is struck from below at the exact moment when the desired letter is over the paper. Four messages are sent at the same time in one direction, the line being loaned to each operator in succession for short recurring periods. This is then also duplexed, making eight messages simultaneously over one wire, each, it is claimed, at a speed of 45 words per minute. It does not seem to be used commercially yet, and whether it will be equal to or better than the printing telegraph system which has been in satisfactory commercial use between New York and Chicago for some time, devised by one of our members, can be determined only by equally severe tests.

There were several exhibits of the wireless telegraph system, though none by Marconi's company. The modifications were only in details and did not include any way of making the system selective. It is now being introduced commercially, and there are a number of installations in regular use.

The telegraphone was one of the very few entirely novel inventions of promising value exhibited. This extremely ingenious and very interesting invention of Poulsen, a Dane, has been so thoroughly described in the journals that a mere mention will suffice here. It may be said to be a magnetic phonograph in which a long hardened steel wire is passed rapidly near the magnet of a telephone receiver, the magnetic variations of which are thereby recorded on it in the form of permanent magnetism. By then passing this wire under small pieces of iron attached to a diaphragm, the same sounds are reproduced. I had the pleasure of hearing such a reproduction, and can vouch for the statement that it is much clearer than from an ordinary phonograph, as there is an entire absence of that objectionable scratching noise, there being no mechanical contact at all. Its suggested applications are numerous, including duplex and multiple telephony.

Those interested in the controversy between the vertical and the horizontal telephone switchboard found a good opportunity to compare them, as each was exhibited by its most ardent defender, the vertical board being advocated by one of our large and prominent companies, and the horizontal by a similarly prominent German company which is introducing it in its country, notably in Berlin. The chief advantage claimed for the latter is that two operators sitting on opposite sides can use the same board and that therefore the length of board for the same number of subscribers is halved.

Electrochemistry was one of the electrical classes in which the most pronounced recent development was shown, although the exhibits were not sufficiently complete to show the true state of that art. This branch of electrical science has opened what promises to be one of the important fields in which there is an opportunity for great development. Products which not many years ago existed only as rare and expensive specimens, and some which were not even known, are now made electrically by the ton.

Electric furnaces were shown in operation. There was also a very fine exhibition of the extremely interesting collection of products obtained by Moissan in his classical researches. Judging from two other large exhibits, copper is successfully deposited directly in the form of mechanically strong tubes, simultaneously with the process of electrolytic refining. A single company in Germany refines electrically about 5,100 ounces of gold and 24,000 of silver a day.

A very large ozone apparatus was shown in operation, for sterilizing 200,000 cubic meters of water per 24 hours by the Marmier and Abraham process, but a confirmation of the claims made is very desirable.

The interesting process of Goldschmidt for obtaining very high temperatures of about 3,000° C. by the combustion of aluminium mixed with metallic oxides was well exhibited and deserves mention, although only of indirect interest to electricians. The expense of the aluminium naturally limits its application. But this seems to be more than balanced in some cases by the other advantages. It is already in commercial use for obtaining pure metallic chromium and manganese for the iron industry, and for welding rails and tubes or mending broken iron parts.

In accumulators there was shown a general tendency, though not a universal one, to use Planté positives and Faure negatives, a combination which seems to have given the least trouble. Accumulators are now the rule and not the exception in Continental lighting and traction stations. Now that the fundamental patents have run out in this country, we ought to use them more freely here. As an electrical flywheel and a comforting reserve in a central station, the accumulator has no equal.

It is impossible, of course, from mere inspection, or from catalogue data, to judge of the success of the light-weight accumulator for transportable purposes, notably for the automobile. But from the awards of the jury, which were based on reliable knowledge of their performance, the Fulmen, the Pulvis and the Phœnix were among the best of their kind; all three are French.

The most satisfactory development in primary batteries is that inventors—or perhaps the capitalists—seem to have at last been convinced that it is cheaper to burn coal than zinc.

A very interesting and promising method was shown in operation by its inventor, Rieder, for electrolytically engraving deep, hard steel dies, such as are used for pressing the reliefs on coins and for embossed work in general. A porous negative of plaster of Paris, saturated with chloride of ammonium, is lightly pressed against the steel blank and the metal is dissolved off electrolytically by a current, wherever the negative touches it. The cost is said to be only half that of the usual hand method.

The exhibitions of instruments were very fine, chiefly from France, England and Germany, but it would take too long to enter into a discussion of them here. That a D'Arsonval galvanometer is made with a sensitiveness of $1{\cdot}2 \times 10^{-10}$ amperes per mm. deflection is of interest; it is claimed to be the highest sensitiveness yet reached with that type of instrument. Among the station and laboratory instruments which are not generally used in this country, but which are very convenient, are the phase meters of Dobrowolsky, indicating directly the difference in phase. A curious but characteristically European criticism of a certain world renowned type of American instrument was that "they are bad because they are expensive."

The very general introduction of micanite, an American invention for generators and motors, is of interest.

The electric plant supplying the exhibition did not seem to be a success, judging from the very numerous stoppages and the excessive variations in the voltage.

The largest number of electrical exhibits were naturally from France. Among the foreign countries, Germany was far ahead of all others in importance, and promises to become the leading manufacturing country for electrical goods in Europe, if it is not so already. One company alone employs 14,000 hands, and ranks with our largest American company. It is of interest to us that this successful company uses American methods quite largely. The Reichsanstalt, that creditable German institution, has no doubt contributed to the rapid strides made by that country in the electrical industries, and shows what government aid can do for the industries of a country. England has already started its Electrical Standards Laboratory of the Board of Trade, a very interesting and creditable government department, which was shown to our Institute this summer during its first official visit abroad. France has its "Central Laboratory," and is considering the enlarging of its government department; Russia has a large government electrical laboratory. The United States alone, among the large countries, has practically nothing of the kind.

Switzerland follows Germany in importance. The United States and England were inadequately represented in this department for reasons already mentioned, although there were some excellent exhibits from each. The lists in the catalogues cannot be taken as a guide in such a comparison, because a simple little device of no importance has the same prominence there as a large important exhibit of several thousand horse power of machinery. Moreover, many American exhibitors who were entered in the catalogues did not exhibit. In one class alone, the number of actual exhibitors was only 40 per cent. of that in the catalogue of the United States exhibits, and many of these were quite small. It would therefore not be just to judge the state of this industry in our country by the exhibits or by the awards.

A characteristic difference between American and foreign practice in manufacturing, as for instance such goods as dynamos and motors, is that here the manufacturer establishes certain well studied and well developed standard types and sizes of machines once for all, and then reproduces them in large numbers, making the parts interchangeable. The foreign manufacturer, on the other hand, constructs each machine according to the detailed specifications of the one ordering it. He argues that if he should make bids with standard sizes in stock, the purchaser would accept the bid of some one else, who would construct the machines exactly according to the specifications. As a matter of fact, however, it was noticeable that those companies which have adopted the American method were as a rule the most successful. There is also a field in and around Paris, at least, for American methods of managing and operating electric tramways, as existing practice is there very poor.

Another difference is that here the manufacturer, as a rule, devotes his whole effort to a single class of goods, and makes these in large quantities, while abroad he attempts to make a large range of widely different kinds of articles; this seems practical only when each branch is a large business in itself.

Still another difference is in the fine external finishing of even those parts of an apparatus which are concealed. Their argument is that all parts of a well made apparatus ought to look well, and that it will then be handled with greater care and respect. Here we would consider it a useless expenditure of money to polish all the concealed mechanism of arc lamps, for instance. The foreigner, however, is apt to judge our goods from his standpoint, at least until he can be convinced of their advantages.

The Jury of Awards had many delicate questions to settle, both technical and diplomatic. While mistakes are possible, it is more than likely that complaints of exhibitors can generally be traced to unworthy or inadequate exhibits, or to circumstances beyond the control of the jurors. One-half the jurors were French, and in the electrical group they were very liberal and generous to the foreign exhibitors, more so than to their own countrymen. If they erred at all, it was on the side of generosity, for which they deserve our thanks instead of abuse. Only two of the United States jurors for the electrical group were members of the Institute.

The Electrical Congress was an international gathering of about 1,000 engineers and scientists interested in the subject of electricity, and as a convention it was a great success, giving an opportunity of making many acquaintances and friendships among men of the same calling in widely different parts of the world. The French deserve great credit for its organization and management. A large number of papers were read, varying in quality from very good to poor, reports of which have appeared and are appearing in the journals. The social features of the visits to the neighboring electrical installations were well arranged and very enjoyable. Our Institute was represented by all of its six delegates, three of whom were elected officers of the Congress. All of the official United States delegates were members of the Institute.

As a gathering of official delegates appointed by the various governments to settle questions concerning units, this Congress came very near accomplishing nothing at all. Had it not been for the efforts of two of the United States delegates, both members of our Institute, this very important feature of the Congress might as well have been omitted. It was due to the convincing appeals of our member, Mr. C. O. Mailloux, that the chamber of delegates reversed its former decision to take no official action on units and names, and adopted without a dissenting voice the recommendations of its committee, in which our past President, Dr. Kennelly, ably represented our Institute. These adoptions were that the name of "gauss" be given to the G. G. S. unit of magnetic intensity or flux density, and "maxwell" to the G. G. S. unit of magnetic flux. The practical units will then generally be the kilogauss and the mega-maxwell. All the other propositions of the Institute were withdrawn in committee when it was found that they could not be adopted. The only other action taken by the official delegates was a unanimous expression of opinion that electrical energy should be considered as property to be protected by law like any other.

The reason no further official action was taken concerning names and units, as suggested by the Institute, is, in the opinion of the writer, that our propositions were new to many of the delegates, not having been discussed fully in their different countries before the meeting of the Congress. At the International Congress of 1891, at Frankfort, when our Institute endeavored through its delegates to have the names gauss and henry adopted, the reason for the failure was the same, and in the report of our delegates* it was recommended that in the future our propositions should first be thoroughly discussed in the societies and journals of the different countries, leaving to the Congress only the final decision on well understood propositions. Had this recommendation been followed in the present case, we might have accomplished still more. Any further recommendations of the Institute should be decided upon as soon as practicable and be made the subject of international discussion in the journals and societies in preparation for the next International Congress, whenever that may be.

The first meeting which our Institute held abroad was a memorable event, and bids fair to be the beginning of a series of international meetings of electrical engineers. It brought the Institute into considerable prominence abroad, increased its influence, and afforded great pleasure to those of its members who attended. When it was first suggested by a member of Council, some years ago, to hold a meeting this year in Paris, the proposition was met with some ridicule, but its success and the benefit the Institute derived from it shows that the venture was not an unwise one, and that such meetings ought to be repeated. While we

* Trans. A. I. E. E., vol. 8, p. 546.

may have just pride in feeling that some branches of electrical engineering are better developed here than in other countries, and that our method of manufacturing certain classes of goods is superior, yet we should not forget that others who have worked equally hard in other countries often reach conclusions differing from ours, and which may well be worth our while to consider. Although our typically American practice of manufacturing standard types in large quantities and with interchangeable parts undoubtedly has great advantages, yet that is the very method which tends to retard development in those types, as it makes one hesitate, perhaps too long sometimes, to make improvements. On the other hand, the typically European method of building almost every machine differently gives an excellent opportunity for developing them, but precludes wholesale manufacture at reduced cost. Such international meetings, therefore, can hardly fail to be of benefit to all who take part, as they enable one to find, through personal observation and personal intercourse, that which is the best the world over, just as our home meetings bring before us the best in our own country. If we want to manufacture the best there is, especially if we want the foreigner to buy it from us, we should have international intercourse.

In London, our sister society, the Institution of Electrical Engineers, entertained us with true English hospitality for three well-filled days, with a most delightful programme, in which pleasure and instruction were harmoniously combined. It will long be remembered by the 28 or 30 of our members who attended as one of the most enjoyable features of the whole meeting. In Paris the official joint meeting with the British Institution, held in the National Pavilion of the United States, through the courtesy of Commissioner Peck, was well attended and was followed by receptions of both institutions, visits to objects of interest, and the Electrical Congress, making a total of two well filled weeks of international intercourse between electrical engineers, and constituting one of the most important meetings in the history of the Institute.

The success of our first meeting abroad should encourage us to follow the excellent example of the Institution of Electrical Engineers by making official visits to the different foreign countries to study their practice and examine their work. Our foreign colleagues will then be encouraged to visit our country, as many of them have promised to do next year on the occasion of the Pan-American Exhibition in Buffalo.

NEW SEWER TRENCH STEAM SHOVEL.

A STEAM shovel for digging trenches for large sewers is a great improvement over other known methods.

It is only recently it was thought possible to use a steam shovel successfully for this purpose, but the Vulcan Iron Works Company, of Toledo, O., having had years of experience in building all classes of excavating machinery, and having thoroughly investigated the sewer trench problem, have built a steam shovel for digging large sewer trenches that answers the purpose beyond all expectations, and this has been accomplished within the past year. Three of these shovels are in operation. They are all of different weight and capacity. One of them at Chicago weighs 24 tons and is digging a trench 10 feet wide and 15 feet deep, and has a capacity to handle 800 to 1,000 cubic yards daily. Another one working in the same city weighs 45 tons and is digging a trench 10 feet wide and 18 feet deep, and has a capacity to dig a trench 15 feet wide and 18 feet deep and to excavate 1,000 to 1,500 cubic yards per day. Another working at Summit, Ill., is much larger than either of those described, weighing about 75 tons and having a capacity to dig a trench 15 feet wide and 21 feet deep. It is now digging a trench 14 feet wide and 20 feet deep and handling about 2,000 cubic yards per day. The material handled in each of the above cases is a stiff hard clay in some places mixed with rock.

The small trench steam shovel when shipped is mounted on traction wheels, which are removed when it arrives at destination, and it is then mounted on skids, which are in turn mounted on regular house rollers, all of which are placed directly over the trench, when the shovel is in operation. The larger size shovels are mounted on standard railroad trucks, on which they are shipped. These trucks are removed at destination, and the shovel is remounted in the same manner as the smaller one. These shovels are used economically for digging large trenches for water mains. These shovels enable the contractor to rush his work to completion in less time than is required by any other method. The masons can work directly under the shovel while it is in operation, necessitating the digging up or blocking of only a small portion of the street at any time.

The car of the medium size, or 45-ton sewer trench steam shovel, is 30 feet long, 9 feet 6 inches wide, with 12-foot sills. The steel deck and frame are mounted on railroad trucks, for shipment, and the shovel is remounted on 14 × 16 inch timbers, 28-foot spread, which run on rollers. The shovel is propelled by a hauling drum on counter-shaft by a heavy steel open-link propelling chain. The one and a half cubic yards dipper is of special design for trench work. The ordinary dipper could not be used to advantage for this work. The average cost of running one of these shovels is between $15 and $20 per day.

THE SEWER TRENCH STEAM SHOVEL.

A STEAM SHOVEL EXCAVATED TRENCH.

EMBANKMENT ON SIDE OF TRENCH.

SELECTION AND MANAGEMENT OF AN AUTOMOBILE VEHICLE.

AUTOMOBILE sport numbers new devotees every day. They are often embarrassed in the choice of a vehicle to suit them.

One has seen a sample which some friend has tried and approved. Another has the means to purchase a vehicle which has achieved distinction in public competition. Such persons are their own counselors.

But there are many others who, for pleasure or business, often for both, decide to try the new method of locomotion. As good heads of families, they do not seek to beat a record, or to give their fellow citizens palpitation of the heart. They are content with a vehicle of moderate price, capable of making a speed of 25 or 30 kilometers an hour, in conformity with prudence and legal requirements. Their desire is for the solid and comfortable. They would like to be able to climb a hill without having to set foot on terra firma. Above all, they do not wish to be jolted to pieces or to have their olfactory nerves disturbed by noisome effluvia. Their number is legion, and for them we write.

In answering the question, "What vehicle shall I buy?" we shall present no names and recommend no individual patterns.

At present three sources of motive power are disputing for the mastery—steam, petroleum and electricity.

The wide use of the locomotive first suggested steam. But as the motor and its accessories should be as light as possible and handled readily, petroleum, as it became more and more available, was received with marked favor. To this, it may be said, is due the recent surprising development of the French automobile industry.

But electricity has not had its last word. Its application has, so far, been confined to special uses, as the city service. It awaits the invention of an accumulator both strong and powerful.

Petroleum seems at present suited to the needs of the tourist, who does not wish to be encumbered with a troublesome mechanism or a heavy boiler. The petroleum vehicle requires only a small quantity of water for cooling the cylinders, its storage cells call for but small space, and a few minutes are sufficient for putting it in action.

This class of vehicles will be the best for amateur use until electricity, more cleanly and more obedient to control, shall be able to furnish accumulators less cumbrous and more readily recharged.

In choosing between different systems of petroleum motors, rules cannot be laid down except in a general way. The motor should be strong and simple; the mechanism easy to manage. A glance of the eye, a visit of the oil can to the delicate parts, may often avert many troubles. The traveler cannot, at every stop, make his way under the vehicle.

After deciding on the system, inspect the mechanism throughout, making yourself familiar with every lever, every piece, and its action. Note the parts that appear frail. Peruse the explanations and details of the catalogues. If you do not know what a petroleum motor is, or a carbureter, or a transmission, seek for initial information from a friend in whom you can confide, and discriminate when you are listening to trade recommendations.

In any case, do not commence an apprenticeship on a new automobile. Take lessons. Test different systems with a conductor. Do not put too much confidence in the performance of a vehicle specially designed for trials, kept carefully, and attended by a skillful exhibitor, who knows all the defects of the system and how to palliate them.

As to the power of the motor, always have it guaranteed by a test with the brake, stipulated in the order and executed by a suitable person.

When provided with an automobile, never set out on a trip of any length without inspecting all parts of the mechanism. Scrutinize the pressure of the bolts, the tightness of the joints, the supply of things needed, the working of the valves and springs. Look after the oiling and the tools. Take with you some duplicate pieces, ignition candles, platinum tubes, asbestos connections, springs, screw nuts, washers, a chain, a brake shoe, twine, and a small lifting jack. Clean the chains with a stiff brush and oil them carefully.

If you have a circulating water motor, make sure of the good working of the pump.

If you have electric ignition, look after the wire connections; if ignition by incandescence, heat the burners well, preferably with alcohol.

Before setting out, put oil in the differential, in the *corter*;* carefully regulate the brakes, that they may give the required pressure. For brakes with shoes compensate for the wear with screws and screw nuts.

Then bid the motor go, and set out—if you can. Sometimes the evil spirit in the motor will play you a trick. We will go into some details.

Suppose that your motor is supplied with electric ignition, and that at the start you do not feel the resistance which a sufficient pressure (about two atmospheres) ought to give to the cylinder or cylinders; then inspect, the motor being at the period of compression, the joints, the valves, the ignition candle, in order to

*Casing protecting the chain from dirt.

see if there is not a leakage, in which case there might be a joint to repair. In the recent models the valves can be easily reached. Some of them may be heated, may be twisted. It may be necessary to rotate with emery powder. A spring may have to be replaced.

If your car tells of interruption in the successive explosions, look after the ignition. Inspect the attachment of the wires, and the state of the batteries or accumulators. The batteries ought to give a current of at least 2 amperes to the amperemeter; the accumulators ought to mark 3½ volts by the voltmeter; if not, they need replacing. On the other hand, the spark given by the candle ought to be hot. A moistened candle, or one soiled with grease or dirt, will not work. Therefore, always have duplicate candles.

To avoid imperfect carburization, if you have a carbureter with float, it is needful to clean it out every two days when at work. Make use of good oil only, marking 680° or 700°. Examine the tightness of the tubes.

Regulate the action of the air according to the outside temperature. This is done tentatively; but, as a general rule, go with cold air in summer, and with warm air in winter. When it is cold, shake your carbureter at the start to stimulate the evaporation, but avoid having it too full; if needful, look after the float, or the holding catch, if it is a valve carbureter.

Test the escape valve and its spring. This valve ought to close just at the dead point of the rod; but a little advance is given to the escape, as to the ignition, at the start.

If your ignition is by incandescent tubes, look carefully after the tube connections, and from time to time clean out the platinum tubes with very fine emery powder.

Before the departure, clean the segments of the piston or pistons with a little oil, if necessary.

See that the gearing works smoothly. If the transmission of the movement is by belt, look after the tension, especially with new belts and in damp weather. A well regulated tension is indispensable.

At the stoppages pass the hand over the principal joints to see that the working is easy; if not, give them a little freedom. Cool them on occasion, and lubricate them frequently.

In winter and time of frost great care must be taken, on stopping at night, to empty the water tank, and the covering of the cylinder or cylinders, in order to prevent bursting.

Finally, do not be frightened by this enumeration of the precautions to be taken. It may appear long, but the practice is not difficult. With a little tact, the proper care of an automobile can be acquired readily by a few preliminary lessons.—Translated from Le Chauffeur.

THE GREAT SEA SERPENT OF THE GARDEN OF ACCLIMATATION.

THE sea serpent has always belonged to legend, although some travelers have claimed to have seen it. This gigantic monster was mentioned as long ago as 1555, when Olaus Magnus gave a more than fantastic description of one. In 1821, the Russian traveler Krinkoff claimed to have seen one in traversing the latitude of Behring Strait. The animal was red, of enormous length, and had a head resembling that of a sea-lion.

In reality, a delusion in regard to the existence of such an animal appears always to have prevailed. There is a family of serpents, the representatives of which live at this moment in the sea, especially in the Indian Ocean, and often reach the mouths of rivers; but they are not very large, and offer nothing in common with the gigantic monsters whose existence has been announced by imaginative travelers. It is very likely that the monsters that have caused so much talk are merely simple pinniped mammals of the sea-lion kind, although perhaps larger. None of these problematical animals has ever been captured.

The sea serpent of the Garden of Acclimatation has been easy to acclimatize, for it was manufactured, complete in all its parts, at Paris, and M. Porte, manager of the Bois de Boulogne establishment, has been pleased to accord hospitality to it. Despite its appearance, it is neither of flesh nor bone, but of metal and wood. It was created by M. Walter Stenning, who has patented it in France and other countries, and given it the euphonious name of "Ophion."

As may be judged from our engravings, it is a monster in every sense of the word—an apocalyptic beast such as imaginative explorers have dreamed of.

Visitors to the Garden of Acclimatation stand in stupefaction when they perceive this rolling monster wandering slowly through the alleys and beneath the foliage. The animals in the Garden acted at first like the visitors, and kept their eyes fixed upon the huge reptile, which measures at least a hundred feet in length and 6½ in diameter. The rings that form its body are movable, in order to permit the animal to move in the curves of the alleys. The head is gigantic and the eyes frightful to behold. Seats are placed all along its body, so that visitors, after having become familiar with the monster, can climb up and sit thereon and make the tour of the garden. In reality, it is a true train of bogies, of which the rings of the animal constitute the cars—a well disguised train! All this is propelled electrically. In the rings or segments are arranged electric accumulators which furnish the current that actuates a small dynamo that in turn actuates wheels concealed beneath the animal's carapax. In the head is seated a motorman, who calmly steers the monster in the center of the alleys. Upon the whole, it is very simple, ingenious and original, and certainly greatly amuses both children and adults.—For the above particulars and the engravings, we are indebted to La Nature.

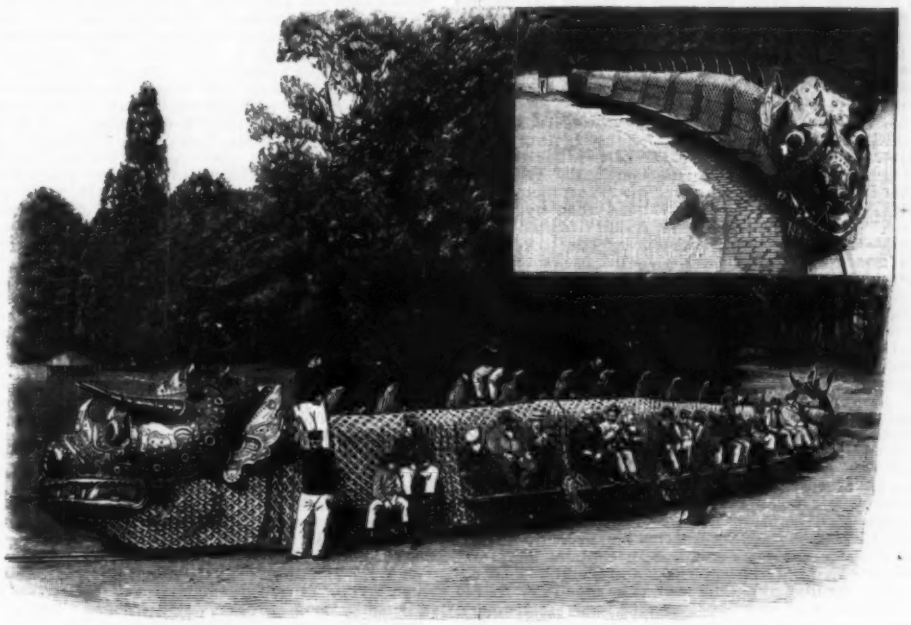


FIG. 1.—THE SEA SERPENT OF THE GARDEN OF ACCLIMATATION.

ELEPHANT HUNTING.

THE elephant hunt, which is perhaps the most interesting sight in Siam, is an annual event, which takes place at the kraal in Ayuthia—the ancient capital—a town of considerable importance on the Meinam, some fifty miles north of Bangkok. It is the occasion of a general holiday. Banks and offices are closed. Ministers, consuls, missionaries, lawyers, doctors, merchants and clerks join in one gigantic picnic up the river. There are no roads to Ayuthia, so they must go by water. The more fortunate travel in well appointed houseboats, others in anything, from small launches to large river steamers, while members of the club generally charter a mammoth steam wheeler. And, to add éclat to the event, the hunt is directed by one of the princes—on the occasion I describe by a brother of the king.

The kraal, corral, or panëet, which was built more than a hundred years ago, is a large inclosure 202 feet square, surrounded by a brick wall nine feet high, varying from thirteen to twenty feet in thickness, with a parapet on each side, forming a fine promenade shaded by several trees whose roots are deeply embedded in the brickwork. Three sides of the square, reached by steps from without, are open to the general public. There is a raised platform over the center of the south wall, forming the grand stand, for favored Europeans and natives, which is roofed by a typical example of Siamese architecture, and consists of a central cruciform part with the arms extended by two lengths of gable on either side, each lower than and projecting from the other, which gives the impression that they are telescopic, and can be run in or out to suit requirements. There are two entrances, one in the north wall, in front of the grandstand, and the other in the southeast corner, both guarded by strong and ingeniously contrived gates, two at each entrance, composed of two heavy timbers hanging on pins from crossbeams above and reaching below the level of the ground, where they fit into a groove. These are drawn apart at the bottom by small windlasses, and when open form an inverted V, with just room enough for one elephant at a time to pass through. On the lever being released they close instantly by their own weight. About twenty-four feet within the walls is a smaller inclosure fenced by palisade of huge teak logs planted in the ground so closely together that there is only space for a man to squeeze between them. The enormous strength of the fence is at once apparent from the size of the timbers, many of them being upward of four feet in circumference. I measured several, and found one five feet nine inches around. The fence is further strengthened by horizontal beams firmly lashed to the logs a foot or so below their heads, and from these struts rake backward to the foot of the wall; the whole forming an inclosure capable of resisting a tremendous pressure from within. In the middle is a shelter or refuge composed of a clump of teak piles supporting a wooden tower with a three-tiered roof rising to a graceful needlelike spire. This also forms an obstruction to the movement of the animals when excited, and serves as a center around which to "mill" the herd. In this kraal the catching takes place. The term "hunt," although invariably used in Siam, is misleading, as the real hunting is done in the jungle by the natives, who drive in the wild elephants.

A GREAT POPULAR OUTING.—The general interest starts with the arrival of the animals, the day before that appointed for the catch. Ayuthia then appears like a city of the dead. All the busy shops are closed, the floating houses and huts are deserted, and large boats and steamers that cannot go up the klong or canal to the kraal are moored to the banks or anchored in the stream. But a mile further up all is gayety and animation—a second Henley! The river, lined with launches, houses and chow boats, is simply alive with canoes, sampans and small craft of every description. Europeans are camping out in the temple rest-houses, or wat salas, and the banks are crowded with thousands of brightly dressed natives, eager and excited, conspicuous among whom are the foreigners—especially the women. The massive brown walled corral looks solemn and imposing in contrast to some graceful green and red roofed temple buildings half a mile across a pleasant stretch of springy sward. An hour is quickly whiled away here, greeting friends and watching the habits of a goodly variety of Eastern races. A sharp eye at last detects a dark mass emerging from a fringe of jungle on the far side of an open expanse of sun-dried paddy fields, and the shout "ma laaw" is taken up all over the ground, as the people rush to secure good places for seeing the animals ford the river. One by one the herd, numbering nearly four hundred, comes into view, rounded up and led by the trained elephants. There is no hurry—they take nearly an hour to do a mile. One would think, to see their measured steps, that they could not go faster; but only get them excited, and see the rate at which their clumsy legs can carry their ponderous, swaying bodies!

It is a strange sight to see them sliding down the steep bank into the river, with their back legs stretched out behind. And with what evident delight they play about and cool themselves by blowing shower baths of water over their backs! After a few minutes the mahouts prod their mounts and lead on, followed by the whole herd, which is bunched together by out-riders on the sides, who keep in stragglers. The kraal is only a couple of hundred yards from the river, and there is a funnel shaped inclosure extending from the north gate to the ford. Into this the animals are slowly led—for they must now be kept very quiet. One leader and then another passes through the narrow gateway, followed by some confiding friends. The decoys stand near, by way of encouragement to those in the rear, which are imperceptibly crowded forward. A few get restless, but before long they are all safely in, and the trained elephants slip out through the other gate. Then it is that the wild ones realize that they have been trapped, and, madly eager to get out, trumpet, bellow and groan, creating, as a local paper

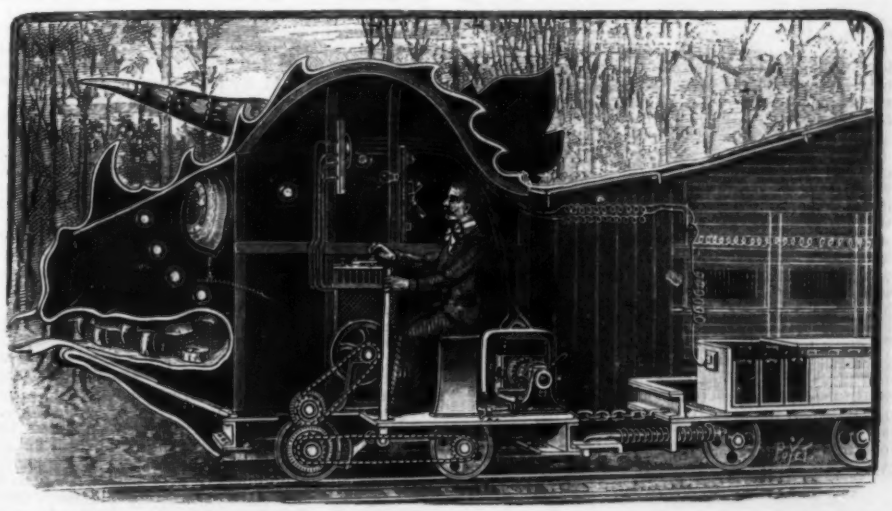


FIG. 2.—INTERIOR VIEW OF THE MOTIVE MECHANISM OF THE SERPENT.

truly said, "a scene of such confusion that no two people saw it alike." The walls now swarm with spectators, who amuse themselves by watching the bewildered beasts, some of which seem to resent their imprisonment, while others are indifferent, and others, again, engage in settling private quarrels or roaring defiance at the gallery. One inquisitive youngster, destined for a civilized and useful life, tried to squeeze between the piles of the refuge, and got jammed across the ribs—the thickest part of his body. His efforts to get free attracted his friends, who watched him while he struggled and bellowed. One big fellow tried to push him back, but failed; then there was a pause, during which one could almost see them thinking, and another, having apparently worked it out in his mind, tried from behind, and, fairly lifting him off his legs, pushed him through, amid shouts of applause from the crowd. A native put his head between the timbers of the fence and was immediately charged at by a large bull that had been busying himself by raking up with his forefoot little mounds of earth, heaping them on the end of his trunk, and then blowing them over his back. Many others were doing the same thing; but their object was not very evident. I believe it was meant as an insult; it looked like one. I was told that when the ground is wet, and they cannot throw earth about, they plaster great cakes of mud on their foreheads.

There were three baby elephants, and one only ten days old, that had been carried across the river in his mother's trunk, attracted much attention; but he kept himself so carefully between her legs that not once did he seem in the slightest difficulty, even when in the thick of a crush.

FOOD FOR THE CAPTIVES.

A feeble attempt was made at feeding the animals; but with their enormous appetites, it was like offering them crumbs. The few small bunches of grass thrown in they picked up in their trunks and, after carefully striking them against their legs or a post in the fence to shake off any dust or earth, conveyed them by graceful action to their mouths. The extraordinary flexibility and diversity of movement possessed by this appendage are attained by a wonderful interlacing of, according to Cuvier, nearly forty thousand muscles. Bananas were, of course, easily managed; but their efforts to chew up cocoanuts whole were not generally successful, as their slippery coats made them difficult to hold, and, as a rule, they are too large for their mouths. One or two small ones were safely negotiated; but when convinced by ineffectual efforts that it could not be done, they place the nut under their feet and crush it flat. Of course the milk is lost; but they seem to keenly enjoy what is left—the shell and husk. This, when green, contains a vile-tasting sap; when dry, is used for making cordage and door mats! The prince selected the animals to be captured next day, and gradually the crowd dispersed, but the bellowing of the herd continued for hours. It sounded unearthly by day, weird and uncanny by night.

The catching began the next morning at 7 o'clock, when seven large tuskers entered the kraal, each ridden by two men. The mahouts, who were armed with short sticks shod with iron hooks, sit with their legs behind the ears, and their feet inserted in a band passing round the neck. This is in place of stirrups, and enables them to lean forward or sideways without danger of falling off. Each one also carries a bamboo pole; and to this is fastened the slipknot end of a rope of buffalo hide, some forty or fifty yards long, which is coiled on the animal's back, and secured to a rattan girth passing round its body. The girth also helps to steady the second man, who kneels or sits, monkey fashion, on his heels perched over the hind quarters, with a wooden club tied to his wrist. This and the prod are for persuading their mounts, and at times are pretty freely used. The trained animals wander about among the others in an apparently aimless sort of way, but all the time are trying to approach one of the selected elephants, which they follow round the inclosure, until a mahout, leaning forward, is able with his bamboo pole to slip the noose over one of the hind legs. The assistant tugs at the rope for an instant and drops the coil on the ground. As quietly as before the operation is repeated, and another noose is attached to the other leg. This may sound very easy, but, judging from the number of failures, evidently requires much skill and practice. The mounted men appear to be absolutely at the mercy of the wild animals; but though it would have been an easy matter to pull them off, not once did I see the slightest attempt to attack them, while any one on foot was promptly chased out.

HOPELESS STRUGGLES.

The poor fellow that has been noosed seeks refuge in the thick of the herd; but the mahouts, by milling them round the kraal, gradually corner him, and attendants outside the palisade quickly secure the ropes to the piles or trees. The animal dashes off in a wild effort to rejoin the others, and the shock lifts his hind legs clean off the ground, or throws him on his knees, and the creaking of the timbers is mingled with a roar of rage. He is allowed to do his best to get loose; but repeated attempts convince him that it is hopeless, while straining and roaring soon tire him out. While No. 1 is proving to himself the impossibility of escape, the tame elephants keep most of the herd bunched together on the other side of the kraal; but the condition of the prisoner arouses a good deal of interest, and he is visited by friends, actuated either by curiosity or pity, who look on with a puzzled expression and blow little clouds of dust in the air. One youngster, that walked up with an inquiring air, was promptly charged square in the ribs, and sent rolling on his back. As he lay there, with his legs quivering in what seemed a death struggle, many of the Siamese shouted "tai laaw"—he is dead! But the poor little fellow was only seeing things upside down; for when an attendant helped him to raise his head, or rather turn it over, he righted himself and trotted back, bellowing, to the others. One can hardly say their massive features are expressive; and yet there is unquestionably a marked evidence of intention, if not in their huge faces, certainly in their actions.

TETHERING THE WILD ELEPHANTS.

The captured elephant soon becomes quieter, and is worked close up to the piles, where he is again secured with only a few feet of tether. This, though not devoid of interest, is the slowest part of the whole show, for it takes infinite time and patience. The trained tuskers stand round and gradually crowd him over, but without the least suspicion of force. If he makes a charge for liberty they begin again, and get on the other side of him as quietly and unobtrusively as if they had forgotten his existence. Sometimes for minutes together there is no movement; but slowly and surely they get him where he is wanted. Now that he is tied up short, the next move is to place a rawhide collar round his neck and lash it to those worn by the decoys, three of which are told off for this work, one on either side, while the third, standing close behind, vigorously butts him if any attempt is made to back out. Forward he cannot go, as his legs are still secured to the fence timbers. The collar is held open by the mahouts on each side, who, watching their opportunity, slip it over the trunk and then lace the ends together at the back of the neck. But this is not accomplished in a minute, nor without resistance from the captive. And it is a matter of great difficulty to dodge the mobile trunk. In fact, in no case was it done until the animal was more or less exhausted. While this was going on, our friend repeatedly put his trunk down his throat, where he loaded it with water, and then squirted it over his back. When he was no longer able to do this, the mahouts poured water from the bamboo joints on his head to cool him. An elephant's stomach somewhat resembles that of a camel in having, apart from the digestive cavity, a chamber capable of holding ten gallons of water, which, by peculiar muscular action, he is able to convey to his trunk. The collar being properly adjusted is next lashed to those worn by two of the decoys, and thus fettered he is half dragged to the gate, occasionally being assisted by the third, who walks in the rear, embracing with his tusks the hind quarters of the prisoner. Through the gate only one can pass at a time; but the ropes are still trailing from his legs, and outside the walls he is again harnessed up and marched off to the stables, where he is firmly secured with his neck close against a great post let deep in the ground. It has taken an hour and a half's fight against odds of three to one plus human intelligence to bring him to this.

His exit was followed by a unique sight, that few who witnessed will ever forget. One of the herd tried to get through the gateway, and his example was followed by his friends, who crowded on him. Others piling up on these from behind formed a gigantic surging scrimmage of some seventy wild, excited beasts, all bellowing and grunting, except those who were nearly crushed out of shape and breath. The pressure against the palisade was enormous. The timbers bent and creaked. The natives, shouting and yelling with excitement, clambered on the wall. The elephants roared and heaved with a will. It was a grand sight, and lasted ten minutes, during which the attendants had been unmercifully prodding them with spears.—The Cornhill Magazine.

THE NOVEMBER METEORS.

THE returns from most American observers of the meteor swarm of 1900 have been received and they are disappointing, says Prof. E. S. Holden in The New York Sun. At Washington fewer Leonid meteors were seen than in the two preceding years; in New Haven only a few meteors have been photographed; the tale is the same from the Yerkes and Harvard College observatories. At the latter some seventy meteors in all were seen, half of them Leonids. At Northfield, Minn., some seventy Leonids were seen, and some photographed. The display began about 2 A. M. of November 14 and lasted until daylight, when the meteors were most plentiful.

The swarm of November meteors, the Leonids, so called because they appear to radiate from a spot in the constellation Leo, is no new thing. Showers of shooting stars from this radiant have occurred during the past ten centuries and have been recorded as remarkable in the years A. D. 902, 934, 1002, 1101, 1202, 1366, 1533, 1602, 1698, 1799, 1833, 1866. In each and every year there are meteors from this radiant. In some years the showers are splendid and impressive, and it was hoped and expected that 1899 would bring one of the great displays. It has not done so. This could not have been anticipated with the knowledge at hand. The non-appearance of a great shower points to the effect of large planetary perturbations of the meteor swarm, principally by the planet Jupiter. It is the purpose of this article to say something on the question of astronomical predictions in general, to give a brief account of meteors in general, and especially to describe the phenomena of the November swarm of Leonids.

It is necessary to make a distinction between the prediction that a meteor shower is likely to occur on an assigned date and astronomical predictions which announce the occurrence of eclipses of the sun, transits of Venus, occultations of stars and planets, and the like. One reads in The Nautical Almanac that an eclipse of the sun by the moon is to take place on a certain day at a given hour, minute and second. When the day arrives, the eclipse duly occurs as predicted with an error in the time of not more than a couple of seconds or so. What does this signify? It means that the orbit of the earth about the sun and of the moon about the earth are so well known from past observations that the time when these three bodies shall be in the same straight line, which is the condition for an eclipse, can be predicted with an exceedingly small margin of outstanding error. The error observed at any eclipse is made use of to correct the elements of the lunar orbit, and serves to make the predictions for future eclipses more accurate.

The ideal of astronomy is to be able to calculate the circumstances of an expected phenomenon so accurately, beforehand, that the prediction is as precise as the actual observation of the phenomenon, when it occurs. This rigorous ideal has been reached, or nearly reached, in many departments of astronomy. It is even now possible to calculate the position, the latitude and longitude of Jupiter or Neptune on January 1, 1950, at Greenwich, midnight, almost as exactly as the Greenwich astronomers of fifty years hence can observe it. Nor can this be done only for planets. Certain of the comets that belong to the solar system—Encke's comet, for instance—move in orbits that are nearly as well known. A telescope could now be fastened in a fixed position so that Encke's comet would be seen in the middle of its field of view thirty or even fifty years hence, provided the comet itself has not changed in the interval. Similar predictions can be made in thousands of like instances. In these respects astronomy is exact. The case is far different for predictions of the reappearance of swarms of meteors. We know very well that they move in certain fixed orbits. These orbits are nearly as well known as the orbits of the planets themselves. We know that during the past century, or it may be during several past centuries, meteor swarms have moved very much as if they were solid bodies—i. e., they have moved like a cloud of solid particles. It is just as certain that they will continue so to move in the future provided that the swarm is not disturbed and broken up by some extraneous force. If they do not appear at a predicted time, as in the case of the Leonids of 1899, it proves that such a force has been acting and that calculations have not taken account of it. It may very well be that the circumstances of the case are such that it was essentially impossible to take account of the disturbing force. For example, it is perfectly possible, and by no means unlikely, that Encke's comet may in the future be subjected to internal changes, expansions, explosions, that cannot possibly be foreseen, and that will materially alter its motion, or that perhaps will break it into pieces too small to be individually seen. Comets have been so riven by internal forces before this time and may be so riven again, or it is possible, and not unlikely, that a comet in moving about the sun may chance to come very near to a great planet like Jupiter. The effect of such an approach might well be to deflect the comet from its previously followed orbit, to draw it nearer and nearer to Jupiter, to subject it to strong perturbations by the planet itself, or even by the satellites of Jupiter (which are bodies comparable to the earth in size), and to release it, finally, a very greatly changed body, to move henceforward in a totally changed path. Lexell's comet had a history something like this.

Similar changes and catastrophes may occur and do occur to meteor swarms, which, after all, are not single bodies like planets, or even like comets, but mere accidental aggregations of individual particles bound together only by gravitative association, not linked by cohesive powers; a company of individuals, not an organic structure. A swarm of meteors is like a charge of bird shot, each pellet pursuing its own course, not like a cannon ball with a single purpose.

The swarm that produces the November shower of Leonids is not a single sphere of particles closely aggregated. It is an elongated mass at least 2,000,000,000,000 miles in extent. This is the main body, and its transverse diameter is very much less than the figures just given. Moreover, the main body is itself not homogeneous. It is broken up into many agglomerated smaller masses, some dense, some sparse. Before this main body and behind it, stretched along the orbit, are millions of outliers of smaller agglomerations all wheeling along the main path followed by all the meteors. If the earth cuts this path through the thickest part of the main body, we have magnificent showers like those of 1799, 1833, 1866. If the earth passes through the Leonids at a point where the meteors are few, we have the sparse star showers of 1733, 1766, 1899–1900. It is disappointing, no doubt, but is the result of causes almost beyond prediction. Given a sufficient number of returns, sparse or splendid, it will be possible to calculate the shape of the main Leonid swarm and to say beforehand that in such a year such a shower is to be expected, provided always that in the meantime, during the time required to accumulate the data, the internal constitution of the swarm has not been greatly changed. Such changes will arise from perturbations of the swarm by planets—by Jupiter, Saturn, Uranus. In some degree the perturbations by these and other planets can be taken account of. We can say how the orbit of the swarm will be altered. But it will always be quite impossible to take account of the changes in the internal constitution of the swarm itself. The path of a bombshell can be predicted, but no one can say beforehand what the flight of each of its exploded particles is to be.

Up to the early years of the present century little attention was paid to meteors, and no one had any true knowledge of their origin, constitution, or mode of occurrence. For thousands of years men had remarked their sudden and brief appearances in the sky, and certain swarms of them were known to recur every year—"the tears of St. Lawrence" on the eve of the day devoted to that saint, August 9, for example. But the astronomers of the early part of the nineteenth century were busy about other problems. It was not, indeed, until the great shower of 1833 occurred in the United States that scientific curiosity was generally excited. In 1799 Alexander von Humboldt was traveling in South America. In November of that year he was at Cumana (Venezuela), and on the 12th he witnessed an extraordinary shower of meteors lasting about four hours. The whole heavens were covered with fire from the glowing trails left by individual meteorites as they entered our atmosphere, became incandescent by their rapid rush through it, and were dissipated by the intense heat so generated. Humboldt's vivid description of the phenomenon attracted attention in Europe, and other accounts from many points in the western continent helped to stimulate inquiry. In 1790 the Director of the Natural History Museum in Vienna—a museum that now possesses a collection of thousands of meteorites—had declared that while there might have been overwise people in past times who believed in the "fable" of stones falling from heaven, for his part he had no faith in it. A prominent member of the Paris Academy of Sciences made a similar remark in the same year when commenting on a report of the falling of an aerolite in France in the same year.

In 1798 two students of the University of Göttingen (Brandes and Benzenberg) measured the heights of meteors by simultaneous observations upon them from two stations, just as the altitude of a balloon might be determined by measuring its angles of elevation from a station in New York and from another in Hoboken. Such observations prove that the sudden appearance of a meteor takes place at a great height above the earth—from forty to one hundred miles—and suggests that the meteor itself is an extra-terrestrial body, like a small planet, that has previously been quietly revolving in an orbit about the sun and that has come so

close to the earth as to be drawn from that orbit and compelled to fall to the earth's surface, or at least to move toward it with increasing speed until the material of its mass is all burned out.

Meteors move about the sun in orbits just as the planets do. The vast spaces from the sun to Neptune are filled with them. When we think of the planets as alone occupying the huge sphere within which Neptune moves (a sphere 5,583,200,000,000 miles in diameter) the celestial spaces seem empty indeed. There are only eight major planets (Mercury, Venus, the Earth, Mars, Jupiter, Saturn, Uranus, Neptune) and their satellites. Even if we add the hundreds of asteroids or minor planets (perhaps there may be a thousand of them), still the spaces seem empty. But they are on the contrary filled with meteoric bodies by millions and thousands of millions. Every day the earth in its movement along its orbit (some eighteen miles per second) meets with fifteen to twenty millions of meteorites. We must imagine the celestial spaces, then, as full, not empty. The single meteorites are, on the average, about 250 miles apart. They vary greatly in size. Those that produce the ordinary shooting stars are exceedingly small, perhaps no larger than the head of a common pin. Many larger ones there are, for they have fallen upon the earth as aerolites or bolides, and the unconsumed mass of certain of them weighs as much as four tons. These are the meteorites of our museums, and it is calculated that on the whole earth several hundred fall yearly. A bombardment by such missiles would be no light matter. On the other hand, the ordinary shooting stars never reach the earth as solid masses at all. They are volatilized, turned into gas, burned up, as it were, before they touch its surface.

A little mass of matter moving in space—a meteorite—comes within the sphere of the earth's attraction and enters the atmosphere with a high velocity—thirty miles per second, for example. Its velocity increases as it falls. Friction against the air turns the energy of the body's motion into the energy of heat and light. When the velocity is as great as thirty miles per second, the meteorite becomes incandescent and melts away into gas. The smallest bodies are almost instantly consumed. The larger ones melt from the surface inward toward the interior, and only the very largest have too great a mass to be consumed during their flight through the atmosphere. The centers of such large masses will remain cold (at the temperature of space or near it), while their exteriors are white hot. Pieces of the Dhurmsala (India) meteorite were picked up coated with ice.

There is a distinction to be drawn among such bodies simply on account of their size. Then there are more important differences due to a difference in their mineral and chemical constitution. Nearly all the aerolites (large masses) that have been seen to fall are masses of stone, while a very few—some four per cent. of the number, perhaps—are nickeliferous iron. These masses have been carefully analyzed, and it is very significant that not a single new chemical element has been found in any one of them, although about twenty-five of the known elements have been separated. This shows, in so far, that the universe is one as to its materials. The aerolites have an origin which is certainly extra-terrestrial. Not one of them has ever touched the earth before its fall; yet they are all composed of terrestrial elements, well known to us. We have reason to suppose that the meteorites that are visible as shooting stars are of similar composition, though it is a supposition difficult to demonstrate, because such small masses are entirely dissipated during their fall. Such observations as have been made of the spectra of shooting stars do not contradict this supposition, if, on the other hand, they do not as yet fully demonstrate its truth.

The apparent brilliancy of the brightest of the aerolites exceeds that of any of the stars or planets. Some of the shooting stars are as brilliant as the brightest stars—as Sirius, Venus, or Jupiter. Most of them are several hundred times less bright. Their absolute brilliancy is perhaps about that of an ordinary incandescent electric lamp.

Shooting stars may be seen on any clear night by a few minutes patient watching. At times they fall in thousands, as in the case reported by Humboldt in 1799. In 1833 there was an immense shower in the United States. At any one place something like a quarter of a million shooting stars were seen, literally filling the sky with their brilliant tracks. An eye witness declares that they fell as fast as snow flakes in a storm, and these were brilliant flakes of fire, not snow. The negroes in the Southern States were prostrate with terror. A cooler observer is said to have looked at the starlit sky on the succeeding night with wonder; he thought the sky would be empty; that none of its stars could possibly be left to shine! It was noticed that the meteors of 1833 did not fall at random. Their tracks all diverged from one and the same spot in the sky, from a spot within the constellation Leo. (They are now called, for this reason, Leonids, just as other swarms are called Andromedes, Orionid, etc.) A well-known theorem asserts that if the paths of all these shooting stars seemed to diverge from one point when the paths were perspectively projected on the celestial vault, then their real paths in space were parallel and all passed through a certain area. Past records of similar showers were unearthed, and Prof. Newton, of Yale College (to whom, with Adams, Le Verrier, and Schiaparelli, a great part of our present knowledge is due), found that meteor showers corresponding to the November showers had occurred, with few exceptions, every thirty-three or thirty-four years since the year A. D. 902. There was then a swarm of such bodies revolving in a huge orbit of its own, and this orbit intersected the earth's orbit at the place occupied by the earth on November 14. When the meteor mass was at that particular point of its orbit at the time that the earth was there (November 14), then we might expect a shower. This actually occurred on nearly all possible occasions every thirty-three years. But it is noticeable that in 1733 and in 1766 as well as at other times there are no records of such a shower. A great shower was predicted for the year 1866, therefore, and the shower punctually took place. The meteors fell at the rate of several hundred per minute and made a great spectacle. Some of the single shooting stars were of great brilliancy—as bright as Venus. In 1899 another shower was due, but although more meteors than the average number for a November night were observed, there was no great shower—nothing like the showers of 1799, 1833, and 1866.

It was, therefore, supposed that perturbations of the meteor swarm by the great planets had occurred (the matter is not susceptible of exact calculation) and the shower was looked for in 1900, therefore.

The history of meteors is closely bound up with that of comets. The connection is close. Even in 1833 it was recognized that the swarm of November meteors revolving about the sun was, in itself, not unlike a comet; an invisible comet, to be sure. The August meteors—the Perseids, which radiate from a spot in the constellation Perseus—are as well marked a swarm as the November meteors themselves. The August meteors also move about the sun in an elliptical orbit whose shape and size were duly calculated. Comparing this orbit with the calculated orbits of known comets, the very remarkable fact emerges that the August meteors move in exactly the same orbit as the bright comet of 1862. As that comet moves about the sun in its own path, these meteors follow it in the very same path. The November meteors likewise move in the path of the comet of 1866. As the comet moves, the meteors follow it. Corresponding facts are true for other comets and swarms of meteors which follow them as they circulate about the sun. The conclusion is near at hand that the swarms of meteors are themselves nothing more than the débris and disintegrated fragments of the parent comet, and in a general way this conclusion is undoubtedly true. Comets do disintegrate and break up. Such catastrophes have several times been seen. What becomes of the fragments? Theory teaches that the débris will follow the parent comet in its orbit around the sun. Speaking generally, it may be said that many known meteor swarms are due to the disintegration of comets. It is, perhaps, not yet safe to say that all meteorites have an origin of this kind. Some comets and some meteor swarms certainly stand to each other in the relation of parent and child. The November meteors are the débris of Tempel's Comet of 1866.

Different swarms of shooting stars have different and peculiar characteristics. The Perseids, for example, are yellowish and move with medium velocity. The Leonids move very swiftly and are characterized by a greenish or bluish tint and by persistent, long-continuing trains. The Andromeds move slowly and are reddish in tint, with short trains. Variations in the rapidity of motion are readily explained by the geometrical circumstances of the motion of the meteorites referred to the earth, but variations in color must be due to differences in material, and variations in the length of trains depend upon the rapidity of motion, upon the size of the meteorite and upon its material.

DRIFTWOOD.

TRAVELERS along the Alaskan coast tell of heaps of driftwood strewn here and there along the beach. These are the contributions that the shores of Asia have been making for centuries to the American mainland, says Cyrus C. Adams, in an interesting article entitled "Drifting Over the Sea," which appeared in The New York Sun. In these piles of drift on our subarctic coasts are many specimens of the flora of tropical and sub-tropical Asia. Many trees were apparently uprooted by some terrible storm and borne away by rivers to the ocean, where they began their long sea voyage. Some of the tree trunks are 150 feet long, and logs are found 8 feet in diameter. The bark is usually worn away by the long immersion in salt water. The great carrier of this debris is the Kuro Sivo, the "Gulf Stream" of the Pacific, which brought the wreckage from Asian forests. Similarly, great pine trees from Oregon and Vancouver have been set adrift and carried slowly southwestward, finally stranding on the eastern and northern shores of the Hawaiian group. The natives of the Sandwich Islands formerly believed that their ancestors had come from the far East, drifting to the islands in their boats, just as the trees came to them.

No advantage has been derived from the Asian timber thrown up on the Alaskan coast, but the Esquimaux in East Greenland have found the driftwood cast upon their shores, after the long journey from the Siberian rivers, to be of the greatest possible value. Strange to say, 300 natives of this tribe had never seen a Caucasian, nor heard of any other part of the world before the explorer Holm reached them, yet they had many implements made of wood that had come half way round the world. Their dog sledges were made of timber that undoubtedly grew on the banks of the great Siberian rivers.

Nansen also mentions the finding of large amounts of Siberian, and to some extent also American driftwood, which he had seen floating near Jan Mayen and Spitzenbergen. Its appearance generally indicated that it had not been in the water for a long time. Vast quantities of Siberian driftwood are found on the eastern coast of Spitzenbergen and lesser islands between Europe and Greenland. Norwegian fishing boats use thousands of glass balls as floats, and some of them were found on the western coast of Greenland, where they are evidently carried by the branch of the Gulf Stream which, after nearing the shores of Norway, turns north and merges with the west-bound current from Siberia. A considerable quantity of timber is carried out by the Orinoco, Amazon, and La Plata Rivers, and borne over the sea in various directions, according to the trend of the currents.

Parts of the river banks are sometimes torn away and carried down stream with the insects and reptiles which happen to be upon them. These floating islands, as they are called, may travel a considerable distance out to sea, until the waves tear them to pieces and scatter their fragments over the ocean floor. In 1898 there is proof that a bit of land torn from some coast or river bank and crowned with vegetable, if not with animal matter, drifted half way across the ocean. This remarkable mass was first seen in the Gulf Stream off the coast of Florida, and its size was stated to have been two acres, but this may have been exaggerated. It was seen again once in the longitude of the Bermudas and the latitude of Wilmington, Del. It was then in the center of the Gulf Stream. The mass was lifted above the general level in one part until the bushes that crowned it were 30 feet above the sea. It was then in plain view at a distance of seven miles. When it was seen at this time, it measured about 110 feet on each side. It was seen again a month afterward, a little north of the latitude of Boston. Two weeks later two vessels came upon the traveler from the tropics and it was having a hard time. The floating mass, however, was not entirely destroyed, for it was seen again within a few days, and it is probable that the October storms finally tore it to pieces. It is believed that it came from the Orinoco River, and it is known to have traveled 1,075 miles, and its total journey might have been at least twice that distance.

DECOMPOSITION OF NITRIC ETHERS AND THE RELATIVE STABILITY OF EXPLOSIVE SUBSTANCES.*

THE ethers in general are decomposed by the hydrated alkalies, with renewal of the acid and the alcohol which have engendered them. But nitric ether offers certain exceptions. So I have stated that nitric ether, treated by concentrated alkaline solutions, may renew the methylic and ethylic ethers, instead of the corresponding alcohols.†

In operating with pure ethylnitric ether, rectified at fixed point, and solid potassa, inclosed together in a tube at 100°, I have noticed that a brown humid matter is formed in abundance, similar to the products of the aldehyde, treated by the potash. This formation could not take place except from the fact of a simple renewal of alcohol, a compound not attacked by solid potash at 100°. The generative reaction of aldehyde has then been effected, not in the formation of nitric ether, but in its decomposition, an atom of the oxygen of nitric acid, or rather of the potassium nitrite produced, having passed over the alcohol, furnishing potassium nitrite and aldehyde.

This reaction disengages more heat than a simple renewal of alcohol, or +22·5 cal., the calculation being made for dilute liquors, and consequently a figure notably higher on account of the solid state of the potash and the polymerization of the aldehyde. These are quite characteristic circumstances.

Analogous phenomena, and still more characteristic because they occur in more diluted liquors, have been observed with the nitric ethers of polyatomic alcohols, notably with nitro-glycerine. Under the influence of the potash, there is renewed at the same time as potassium nitrate a proportion more or less considerable of potassium nitrate. Now, if the renewal of the nitric acid corresponds to that of the glycerine, that of the nitrous acid implies the simultaneous formation of a different and more oxidized product, such as an aldehyde or its derivatives.

There are two ways of regarding this reaction: one with reference to the formation of the aldehyde occurring in the initial preparation of the nitro-glycerine, the other only to its destruction by the alkalies. It is possible that there may be occasion for both with the same sample. Let us look at the normal reaction:

$$C^3H^5(AzO^3)^2O^3 + 3\,KHO = C^3H^8O^3 + 3\,AzO^2K.$$

We would have for example:

$$C^3H^5(AzO^3)^2O^3 + 3\,KHO = C^3H^4O^2 + H^2O + 2\,Az\,O^3K + AzO^2K.$$

But the formation of some porportion of glyceric aldehyde‡ may also take place in the initial reaction:

$$C^3H^5O^3 + Az\,O^3H = C^3H^6O^3 = Az\,O^2H + H^2O,$$

the nitrous acid entering into combination with the glycerine to form an ether; for example, a mixed ether, or a nitroso-nitric ether,

$$C^3H^5(AzO^3)^2(AzO)O^2,$$

of which the centesimal composition is scarcely distinguished from the nitro-glycerine. It would be an ether that would furnish the nitrous ether found at the same time as the nitric ether.

The very interesting observations of M. Leo Vignon on the nitro-celluloses cast a new light on these reactions.

I recall them because this order of phenomena offers a special interest for the study of the stability and conservation of the explosive matters formed by nitro-glycerine, nitro-mannite, and other nitric derivatives.

It is clear that such nitric derivatives as have, from the conditions of their preparation, a proportion of aldehydic derivatives would have less stability than when free from such a mixture.

Such an accident is especially to be feared if an acid containing nitrous vapor is employed in their preparation.

An impurity of this kind is scarcely to be ascertained by the methods of analysis of nitric compounds now usually in vogue, which consist in determining the proportion of nitrogen bioxide renewed in their reduction. This proportion would not vary materially, whether the sample were pure or mingled with a nitroso derivative.

These are important considerations, to which it has seemed useful to me to draw attention.

THE REDUCING ACTION OF DENITRIFYING BACTERIA.

By G. AMPOLA and C. ULPIANI.

THIS research has been carried out principally on the bacteria which give off nitrogen with the nitrates, especially the Bacillus denitrificans V, or pseudo-pyocyanic.

Nitrogen combined with hydrogen in the form of ammonia or amine is not set free by the ferment.

Hydroxylamine and hydrazine interfere with the development of the bacteria.

The organic nitrates, which are non-saponifiable in aqueous solution, such as nitromethane, remain unattacked.

The saponifiable organic nitrates, such as nitrate of ethyl, are gradually attacked during the saponification.

Among the ionizable nitrates, nitric acid with the ion H is not attacked, even in centinormal solution.

* From the French of M. Berthelot. Paper presented to the Académie des Sciences.

† Annales de Chimie et de Physique, 3d Ser., t. lviii., p. 447.

‡ This aldehyde being susceptible of changing into binitric derivative on account of its distinct alcoholic character.

The following nitrates are decomposed in the following order, commencing with the one that is the most easily decomposed: Nitrates of cæsium, rubidium, potassium, sodium, lithium, barium, strontium, calcium, magnesium, and glucinum.

The other metallic nitrates are not attacked.

The nitrates of the organic bases, strychnine, cocaine, etc., are rapidly reduced.

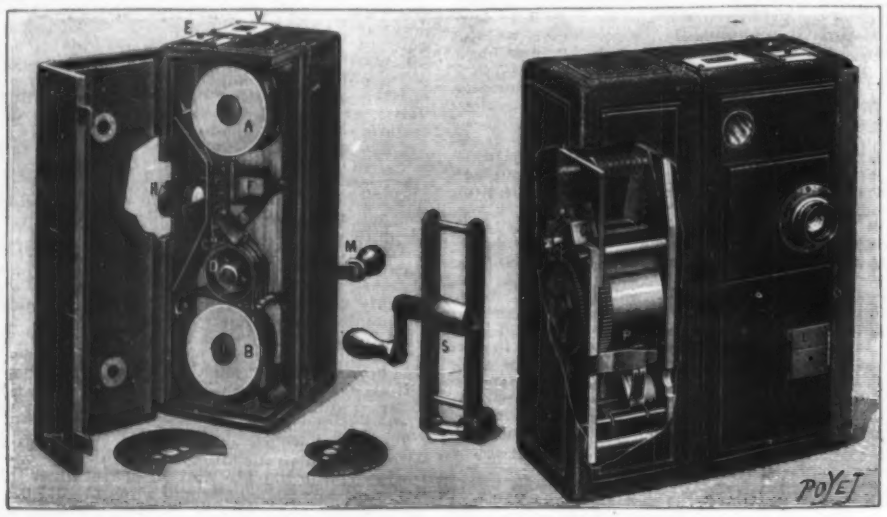
The authors propose classifying the denitrifying bacilli in three categories:

1. Those which destroy nitrates alone.
2. Those which only attack nitrites.
3. Those which act on both nitrates and nitrites.

They have also examined the action of the denitrifying bacilli on arseniates which are reduced to arsenites, on chlorates which give traces of chlorides, and on ferricyanides which are easily reduced to ferro-salts.—Gazz. Chim. Ital. [1], vol. xxix., pp. 49–72.

A POCKET CHRONOPHOTOGRAPHIC APPARATUS.

THERE is a tendency at present toward reducing the size and weight of the cinematograph, as well as the price of it. It is in the production of the negative more than in the purchase of the apparatus that the question of price is capable of intervening, since, as the negative band for the current models always costs about $6, a person is apt to look at it twice before selecting a subject, and the more so in that a positive will afterward have to be made, of which the cost is almost the same. It is not indispensable that a person shall be able to make projections of 30 or 40 square feet at home, in a room of small dimensions. Many amateurs would be content with an image of smaller size, provided that they could obtain a series sufficient to reconstitute the animate motions in a scene that interests them. It is in this order of ideas that M. Gaumont has devised a greatly reduced model of the Demeny "chronophotograph," which permits of obtaining results of which the cost is about a tenth that mentioned above. The mechanism of the apparatus is identically the same as that of the models of larger dimensions. We find in it the spools, *A* and *B*, upon which the film is wound; the cam, *C*, which constitutes the Demeny patent and permits of the arrest of the film for an instant back of the objective, *H*; the toothed wheel, *D*, that always acts without traction upon a slack portion actuated by the cam; the window, *F*, which turns down upon the band in order to keep it in place and permits of illuminating it from the rear when a projection is made; and, finally, all the mechanical details that make of the chronophotograph the excellent apparatus that is familiar to us. But all these parts have been reduced, and the whole is but 8 inches in height by 2½ in thickness and 3½ in length. The film is only 16 feet in length; yet, since the images are but $\frac{4}{10}$ of an inch in height, there are 500 to the band—a number sufficient to reconstitute an animate scene.



A POCKET CHRONOPHOTOGRAPHIC APPARATUS.

The apparatus is provided with a finder, and is set in motion by means of a winch; but the manufacturer has desired to obviate even the trouble of turning the latter, and has therefore arranged things so that it may be replaced by a clockwork movement that sets the mechanism in operation. This has the advantage of giving the apparatus a greater immobility, and of allowing it to be held in the hand during the taking of a negative. This permits, too, if the apparatus be fixed upon a support, of the operator's placing himself in the scene represented. In order to obtain a sufficient power, it became necessary to have recourse to a spring of quite a large size, and the clockwork movement as a whole necessitated the use of a box almost as large as the apparatus itself; but it is completely independent of the latter, and is instantaneously mounted or dismounted by means of a single screw. It is therefore possible at the last moment to make use of the winch or the motor indifferently.

The part of the band that has been exposed is developed as easily as a negative, owing to a very simple arrangement that consists in placing the band, as it comes from the spool upon which it is wound, upon a frame that is as easily maneuvered as an ordinary plate in the developing and fixing baths.

The printing of the positive is effected by using the apparatus that has served for taking the negative. To this effect, the spool carrying the negative is installed at the upper part of the apparatus upon a small frame, *S*, arranged for that purpose. Then the extremity of the band is secured in a slot, *E*, which serves as an entrance for a conduit that extends to the interior of the apparatus. The spool, *A*, holds an unused band, of which the extremity is placed along with that of the negative upon the actuating mechanism, *C D*. Then one is separated from the other by securing the sensitized band to the spool, *B*, while the negative makes its exit from the apparatus through the passage, *L*. Such arrangements having been made (in the laboratory of course), the objective is removed, and all that has to be done is to turn the winch in front of an artificial light or a window in order to obtain an impression.

The developing is afterward done through the use of the special frame, just as with the negative.

In order to observe the result, it is possible to proceed in two ways. If it is not desired to make a projection, all that has to be done is to replace the positive band in the apparatus as if it were a question of taking a negative, and then to leave the door open in directing the window, *F*, toward the light, and to put the eye to the objective. Care should be taken beforehand to remove the diaphragm from the latter and replace the ordinary shutter by another having a more sloping aperture. This operation is very easily performed, since the shutters are formed of small disks of cardboard that are mounted with a bayonet catch upon the extremity of the axle that sets them in motion.

For a projection upon a screen, the modus operandi is the same; but the condenser of a projection lamp is so arranged as to concentrate the whole of the light upon the window, *F*, turned down upon the band. As a source of light, an Auer burner, or (if it is possible) an oxetheric lamp, is employed, and a 24-inch-square image (quite sufficient for an amateur seance) is obtained. If electric light is at one's disposal, it will be possible to obtain an image of 10 square feet or even more.

This little apparatus will have a great influence upon the popularization of the photography of motion by permitting amateurs to perform all the necessary operations themselves, and with an inexpensive and simple equipment.—La Nature.

THE LINDE PROCESS OF MANUFACTURING LIQUID AIR.

THE liquefaction of air is a most interesting problem that has for a long time attracted the attention of physicists and that has finally been practically and industrially solved, thanks principally to the researches of Dr. Karl Linde.

Without entering into any details, we shall simply recall the fact that the liquefaction of air according to the Linde system is based upon the cooling that air undergoes when it is submitted to expansion and passes from a given to a lower pressure in consequence of the production of an internal work. Such cooling of the air at an ordinary temperature is only 0·25° for one atmosphere of pressure. In order to obtain a liquefaction of the air at the pressure of the atmosphere, it would therefore be necessary to cool it to —191°, that is to say, it would be necessary to compress it to 800 atmospheres before expanding it. Dr. Linde has found it possible to dispense with this enormous work of compression by accumulating the effects of continuous expansion and by not allowing the air to expand up to the atmospheric pressure. The fall of temperature produced by the expansion is proportional to the difference of pressure before and after the expansion of the air. On another hand, the work of compression necessary to carry the pressure from one degree to another that is higher is proportional to the ratio of the two pressures. The best solution, therefore, was to adopt a great difference of pressure. So, in his various machines, Dr. Linde starts from an initial pressure of 200 atmospheres before the expansion, and the pressure reaches but 50 atmospheres after the expansion. The difference in pressure is 150 atmospheres, and the ratio of the two pressures is but 1 to 4. In several models of the various machines, the difference in pressure may vary to 180 atmospheres, and the ratio of the pressures may reach 1 to 10.

The accompanying figure represents the principal arrangements of the machine that was installed at the Exposition of 1900.

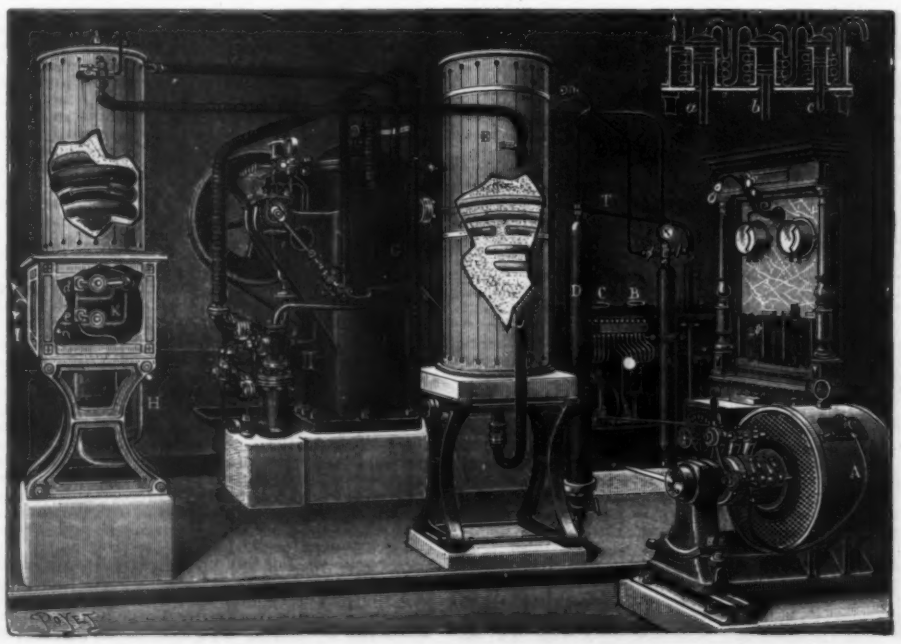
At *A* is an electric motor that actuates a pump which sucks air from the atmosphere and compresses it to 7 atmospheres. This air is then sucked by the low pressure cylinder, *B*, of a compound compressor, which works with an injection of water. This cylinder compresses the air to 50 atmospheres, and under such pressure the air is sucked anew by the high pressure cylinder, *C*, of the same compressor, which in turn compresses it, as well as the air derived from the counter current, to 200 atmospheres.

The compressed air afterward passes into a drier, *D*, wherein it is desiccated over chloride of calcium. It next passes into a cooler, *E*, wherein it is cooled by means of a liquid ammonia refrigerating apparatus. (This latter is seen at *G* in the figure, to the left of the cooler, *E*.) It has been remarked, in fact, that the product of the liquefying apparatus will be notably increased if the compressed air be cooled before its entrance into the counter-current apparatus. Finally, to the left of the refrigerating apparatus, there is a cylinder placed upon a box, *K*, and containing three concentric copper tubes, forming a spiral. The air compressed to 200 atmospheres, upon its exit from the cooler, *E*, traverses the interior tube from top to bottom, expands to 50 atmospheres, and, in the box, *K*, passes through a valve, *d*, and returns through the annular space between the interior and central tubes to a pipe placed at the upper part. This pipe leads it to another pipe, *T*, whence, with the air coming from the exterior and already compressed to 50 atmospheres, it is sucked and again compressed to 200 atmospheres. At *a*, *b*, and *c* are seen the cylinders of the compressors, as well as the coupling of the pipe that leads the air to the compressor after its expansion from 200 to 50 atmospheres. It is here that is found the counter-current of compressed air, which returns anew to the compressor to undergo the same operations again.

In the box, *K*, beneath the valve, *d*, there is a second valve, *e*, through which flows a certain quantity of liquid air that collects in the receptacle, *H*. This liquid is drawn off through a cock, *I*, placed at the side, and the portion of the air that has not been liquefied escapes into the atmosphere.

These air-liquefying machines are manufactured of different sizes, that permit of obtaining from 0·75 to 100 liters of liquid air per hour with respective expenditures of from 3·5 to 190 horse power. In the small installations that produce but from 0·75 to 5 liters per hour, the first low pressure compressor is done away with and the air is sucked directly from the atmosphere and compressed to 20 atmospheres. For such small productions, a refrigerant mixture formed of ice and chloride of sodium or calcium is employed for cooling compressed air. In this way a temperature of from —10° to —15° is reached. The compressed air is sufficiently dried upon making its exit from such a cooling apparatus.

As for the applications of liquid air, they have already been examined in these pages. It is well, how-



THE LINDE APPARATUS FOR THE PRODUCTION OF LIQUID AIR.

ever, clearly to distinguish the possible applications and to put the reader on his guard against applications that are very problematical, and, among these, the use of this material for motive power and for the artificial production of ice. Ice is now obtained by very simple processes, that permit of considerably reducing the net cost. Liquid air has been proposed as a material for the manufacture of explosives, but, according to Dr. Linde, the results, up to the present, have not been very satisfactory. One of the uses to which it may be successfully put is the production of oxygen.

It is true that we are only beginning to employ a system of production that is really industrial and practical, and that future researches may lead to other conclusions.—La Nature.

NEW AND SIMPLE METHOD OF MAKING TELESCOPIC OBJECTIVES.

By EDMUND M. TYDEMAN.

THE first thing that claims attention in the manufacture of telescopes is the object glass or mirror, as this is the very foundation of the whole apparatus; if that be lacking or of inferior quality, the expenditure of time and labor in the mounting and equipment will be useless.

To begin with the simplest but most important matter first is the production of a true optical glass surface for a lens or mirror. Suppose it is desired to make a glass speculum of 10 inches aperture and 6 feet focus, for a reflecting telescope—and a much less ratio of focus to aperture than this is not to be commended, from the difficulty of securing a satisfactory field of view with the shorter foci, the outlying parts of the "field" being troubled with what is now termed "astigmatism" to a very disagreeable extent, so that we must either greatly contract the field of view, or have stars not lying immediately in the center of the field presented to us as oblong disks or with comet-like flares to one side of them.

The process, and the proportions given for making this glass, will be found applicable to any similar glass surface between 12 and 6 inches diameter.

The glass disk can either be cut from a thick piece of rough plate 1¼ inches thick, or it can be purchased in the form of a casting from almost any glass house, in cast disks of 6, 7¼, 8¾, 10 and 12 inches diameter and from 1 inch to 1⅝ inches thick.

The quality of the glass for the above purpose is not of any great consequence, so long as it is uniform and free from surface air bubbles. Light flint glass will be found considerably easier to work, and is capable of receiving a finer polish than plate glass, which is seldom free from troublesome pores; as may readily be seen by examining a piece of ordinary plate glass with a watchmaker's eye-glass. One advantage of using the cast disks mentioned above is that their edges need no turning.

Before commencing to rough the glass out, it will be necessary to provide a gage of the proper curve, if our surface is required to be brought very accurately to the radius proposed. A mirror of 6 feet focus must have a radius of 144 inches, so the beam compass required will be 12 feet in length. Provide a flat piece of planed 1-inch board 15 inches long by 10 or 12 inches wide; and having cut out and carefully flattened with surface plate and mallet a piece of hard rolled sheet brass, 12 inches by 5 inches of No. 16 or 18 gage, fasten it down to the middle of the board with six wood-screws, one about an inch inward from each corner, and one near the middle of each of the longer edges, so that it may lie perfectly flat and solid on the board.

The board, with the brass plate screwed to it, must be nailed to the side wall of a house some four feet from the ground. Just 144 inches from the center of this plate a wood plug is driven into the wall, and sawn off parallel to the face of it, leaving about an inch projecting; in the center of this plug a stout wood screw is inserted, forming a center pin on which is to be suspended the beam of our compass.

Take a piece of planed scantling 13 feet by 4 inches by 1 inch, as flat and straight as possible, to which screw another similar piece 11 feet long edgewise along the center of it, to stiffen it; making a long stiff arm of a T section, leaving at each end about a foot of the longer board projecting, through the upper end of which make a hole to stiffly fit the stout wood screw in the wall above, so that it may swing like a pendulum from it. Upon its lower end is to be fastened a wood block about 3 inches square by 2 inches thick, having a ¼-inch hole passing through its center and through the board to which it is attached, and precisely 144 inches distant from the center pin above. To fit very tightly in this hole make a steel pin from a piece of round ¼-inch tool steel 4½ inches long, one end of which is turned up to a short point like a center punch, the other end being squared. The pointed end is filed for an inch or more into a half round section, which is to be ground up and whetstoned to a true cutting edge, and hardened. This cutting edge and point will project about 1¼ inches below the face of the beam, which is now to be suspended from the pin in the wall some 16 feet from the ground. At the upper edge of the board carrying the brass plate is tacked a strip of wood 1 inch thick, to form a rest or guide for the lower end of the beam to ride on.

Having screwed a monkey wrench or handvise to the squared end of the scribing pin, and having forced the pin through so as just to touch the brass plate, draw it firmly but lightly across, making an even scratch upon it. The plate is now to be unscrewed from the board and sawed in two with a fine saw just above the scratch, leaving the scratch visible on the concave edge of the plate, which must be very carefully filed to the mark with a smooth "crossing" file. This lower half of the gage is now to be screwed down to the board as before, being very careful to get it in precisely the same place. But previous to doing this, it will be well to make a mark with the steel point across the face of the board, and to cut out with a sharp chisel a clearing groove ⅛ inch or so wide and ⅛ inch deep, just above the line.

The brass plate having been secured in its place, and the sharp corners at its extreme ends chamfered off a little, the halfround scriber is pushed so far through its hole that its straight cutting edge may just impinge on the filed edge of the concave gage plate, so that by moving the beam compass backward and forward, it may be made to scrape it to a true curve, the handvise attached to the squared end of the scriber enabling the operator to turn it gradually so as to bring more and more of its cutting edge into operation, until every part of the concave has been scraped up to a smooth and regular edge.

The process of getting up a gage of long radius is thus minutely described because, in object glass making, it will often be necessary to be sure that the gage is true to one-tenth inch of the desired radius. The reason we describe the process of making a true reflecting surface first is that the process which will enable us to prepare such a surface will serve equally well for an object glass surface of the same diameter, while the converse does not hold good by any means.

The other half of the plate, forming the convex gage, is to be very carefully filed and scraped up to match the concave gage, until, upon placing their edges in contact, and holding them up to the light, they shall be seen to touch at all points, and equally well when reversed. They are then laid edge to edge upon a surface plate, and ground lightly together with a trace of finely powdered pumice stone and oil. The ragged edges can be removed with a fine file or scraper before

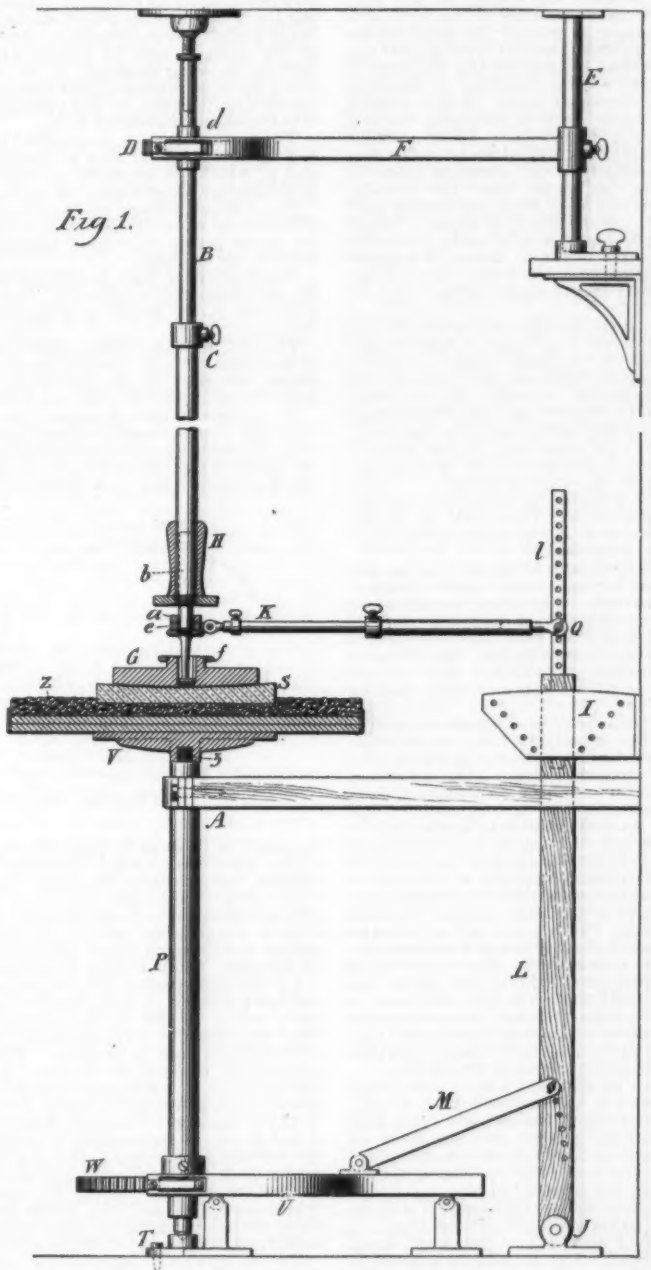


Fig 1.

LENS GRINDING MACHINE.

grinding. The radius to which they correspond should then be engraved upon them.

Now that carborundum, almost rivaling the diamond in its hardness, is to be obtained so readily, glass grinding has in a large measure been deprived of its tedious and laborious character; processes that used to occupy hours in some cases being reduced to minutes by its use.

Disks of glass, as they come from the hands of the molder or caster, while their edges are usually all that can be desired, sometimes needing no dressing at all, come with their faces all more or less irregular and bulged. In the case of a 10-inch or 12-inch disk, the reduction of the two surfaces used frequently to occupy a whole day and the consumption of several pounds of emery powder, unless one had access to power-driven machinery. Now, with the aid of a small foot-polishing lathe and a 6-inch or 8-inch carborundum wheel (No. 65 medium) one may bring a 10-inch disk to the gage in less than one hour; or, if the disk has been cut from a piece of 1⅛-inch or 1¼-inch plate, the worst protuberances of the edge may be reduced by the wheel, and then the disk, having been cemented with a mixture of pitch and rosin to a block of wood, is placed in the lathe. A strip of thin sheet iron about 36 inches long by 3 inches wide, forming a kind of loose sling, is held around it, while it is fed with a thin paste of carborundum, Nos. 80, 120 and 180, in succession, the lathe being pretty rapidly revolved; this will quickly reduce it to a smooth edge. The lathe, if a good one, must be well covered up with paper and rags, or the flying detritus will soon ruin its fitting parts. It is usual to keep an old lathe-head in a cellar or outhouse for this and all similar grinding purposes; anyway, it should always be taken apart and well cleaned after using.

The only tools besides the lathe needed at this stage of the work are a rule, calipers, straightedge, surface plate, mallet and chisel, plane, saw, gimlet and screwdriver.

In roughing out the surfaces of the glass, particular care must be used not to allow the cutting edge of the swiftly revolving carborundum wheel to be brought too near the edge of the glass, or a bad chip will result. Thus, in scooping out the concave to fit the gage, do not grind the hollow so as to extend it farther than to within ⅛ inch of the edge, and always so present the glass surface to the wheel as to cut from the edge toward the center.

The glass is now to be cemented, by means of a mixture of paraffin wax and rosin (3 to 1), to the top of a barrel or post, the back or flat side uppermost, which is to be made perfectly flat by working over it an 8-inch to 10-inch diameter flat surface plate, or, instead of the surface plate, a disk of plate glass having a block of wood 4 inches by 4 inches, turned roughly into the form of a knob, cemented to it for a handle, may be used. A paste of Nos. 80 to 120 carborundum powder and water is the best abradant to apply, using about half a teaspoonful at one time, working it by hand with 2-inch or 3-inch straight strokes, varied by 2-inch or 3-inch circular strokes every now and then, all the time walking steadily round the post or barrel, and frequently examining the surface with the straightedge. The powder must not be allowed to get too dry, nor must it be watered enough to cause it to run all around; when it gets to be too muddy and pasty, clean it all off, not omitting to wipe the edges well. Do not apply a finer grade of abrading powder until a uniform surface has been obtained free from the pits and marks of the previous powder. When a clear, flat surface has been obtained that corresponds with the straightedge, the glass may be knocked off the post or barrel by inserting the edge of a broad chisel between them and giving it a smart tap with a mallet.

The extreme edge may now be chamfered by applying it to a glassgrinder's Craighley stone; any other stone or emery wheel will make it look coarse or chip

it. The glass is then partly cleaned by scraping, the remains of the cement being washed off with benzine or turpentine, and it is again cemented down with the concave side up. Before this is done, however, it is desirable to see if the disk is parallel, and if it be not, to make it so by grinding the concaved surface upon a flat surface plate or a piece of plate glass, gripping the 10-inch glass by hand, and using No. 100 or 120 carborundum powder, dry, pressing heavier upon the thickest part of the disk while working it upon the plate with circular strokes, until it is found by calipering—and if it is a very particular job, as for an object glass, the micrometer calipers must be used—to have an equal thickness all round. When this is the case, cement it down to the grinding post, using about a tablespoonful of pretty hot cement for this purpose.

Cast a disk of lead or of zinc, or a mixture of the two, ½ inch or ¾ inch thick and 8 inches diameter; with a mallet or hammer, pound the back of it until the other side fits the concave gage. On its concave side cement the wood knob that served as a handle for the glass disk, and proceed to work this metal shell upon the glass, using Nos. 80 to 100 carborundum powder and water, with straight and circular strokes, until it is reduced to an even surface that matches the gage, and until the concave has spread to the very edge of the glass. Watch the surface as the work progresses, and if the concave is getting too deep, flatten the metal disk, and vice versa, should there appear but a slight difference between the surface and the gage, it can be brought right by wiping the abrading material away from the more depressed parts. A tool smaller than the glass will always tend to deepen a concave surface and to flatten a convex one. Large circular strokes tend to abrade away the edges or outer portions of a surface, especially if the abrading material be wiped away from the center every few strokes. Short, straight strokes will wear away the central part of a concave surface. While walking steadily round the post the grinding tool must also be made to revolve gently in the hands. It is better to leave the concave surface rather too shallow than too deep. That is, the convex gage should bear on the center rather than on the edge.

If the glass is a cast disk, the edge will probably not need any chamfering, but if a cut disk, it must be applied to a glass-grinder's Craighley stone revolving at a surface speed of about 1,000 feet per minute, or if this is not available, it can be cemented on to a wood chuck in the lathe, and a little of the very finest grade of washed carbo powder and water applied to the edge, by means of a strip of thin sheet iron or zinc about 6 inches by 2 inches, held on the hand at an angle of 45°, until a chamfer of about $\frac{1}{16}$ inch is produced.

The next thing to be attended to will be the preparation of the grinding tools, *G*. These can be of cast iron or cast steel; the latter is preferable, being more homogeneous and free from faults.

For a 10-inch glass, they may be about 8 inches diameter and 1 inch thick, having a boss 2 inches diameter and 1 inch high at the back; they are to be turned up in the lathe all over, the faces being turned so as to fit the two gages precisely, so that when they are applied to each other and rubbed together, they are found to touch all over; any deficiency in this way must be corrected by scraping, as in making engineers' surface plates.

The convex tool is then held in a vise face upward, while the bright surface is laid out with straightedge and dividers into a system of ¾-inch squares separated from each other by V-shaped grooves rather more than ⅛ inch wide; an 8-inch tool will have about nine squares on each diameter, or about seventy-five altogether. The central groove will be marked out so as to pass $\frac{1}{16}$ inch to one side of the center, and the central groove, at right angles to it, will pass ¾ inch to one side of the center of the surface; thus the system of squares will be eccentrical, this arrangement serving to prevent the tendency that large surfaces have to run into rings or zones of different radii in grinding. The concave tool is left plane in the present instance, but in grinding a convex surface it will be found expedient to groove it, which must be done in a planing machine, and upon the same system of eccentrical squares as detailed above.

The grooves in the convex tool can be more easily filed out with the corner of a heavy 14-inch square file, two strips of brass being clamped to the face of the tool about ¼ inch apart, to serve as guides for the file.

The tools are now to be chucked truly in the lathe while the back is bored in the center with a ¾-inch hole to within ⅛ inch or less of the surface. This hole must have a ⅛-inch keyway $\frac{1}{16}$ inch deep cut down its whole length, which can be done by temporarily plugging up the ¾-inch hole, and then drilling a ⅛-inch hole down it just inside the edge of the plug.

When the iron grinding tool is very heavy, it will be found convenient to have a thread cut for about ¼ inch on the end of the 2-inch boss at the back, upon which a heavy metal ring, *f* (Fig. 1), may be screwed to serve as a handle to lift it by.

The very simple machine and process that has been found to produce a perfectly true surface, either spherical, elliptical, or parabolic, at will, and either convex or concave, and of any focus, from a 6-inch surface of 12-inch focus to a 12-inch glass of 8 feet focus, or one of the same aperture of only 4 feet focus, and by which the surfaces will be made perfectly true to the extreme edge, is now to be described.

Fig. 1 shows the machine of dimensions suitable for grinding up and polishing any glass or metal surface from 6 inches to 15 inches clear aperture. It can be worked with equal facility and precision either by hand or power.

Although the grinding up and polishing to completion, by hand, of a surface of the larger dimensions named is a tedious job, it is by no means a laborious one. The application of power, while it will relieve its tediousness, will not in any way serve to shorten it.

The most convenient place for the machine is a well lighted corner of the workshop, directly opposite to which and about 2 feet from it (forming the diagonal or hypotenuse of the triangle) is securely fastened a beam of wood, *A*, 4 by 2 inches and about 4 feet long, its upper side being some 30 inches from the floor. The front edge of this beam is provided with a journal to carry a vertical steel spindle, *P*, 30 inches long, 2 inches diameter, the bottom of which is pointed to run in a metal socket, *T*, screwed to the floor, the upper end, *Z*, being threaded to carry the chucks of an ordinary 12-inch engine lathe. To the lower end of the spindle, *P*, about 6 inches from the floor, is keyed a 12-inch wheel, *W*, having a fine ratchet of about 400 teeth cut on its edge. This ratchet is actuated by a vertical lever, *L*, 42 inches long, attached to the floor by a hinge, *J*, about 6 inches from the wall; and connected to it is a U-piece which embraces the 12-inch ratchet wheel by means of a double set of pawls, as shown in Fig. 2, so that its reciprocating motion will cause the main spindle to revolve in either direction.

Immediately above the main spindle, and suspended from the ceiling by a ball and socket joint, is a compound brass rod, *B*, about 6 feet long, consisting of two 1¼-inch brass tubes, each about 40 inches long, sliding one within the other, and fitted with a clamping screw, *C*, so that its length can be varied at pleasure; the upper and smaller tube also carries a ratchet wheel, *D*, about 6 inches in diameter, attached to a short sleeve, *d*, sliding on the tube in such a way that it may be clamped anywhere from 3 to 12 inches distant from the ball center or ceiling.

Parallel with the suspended 6-foot rod, and about 15 inches from it, a rod, *E*, about 20 inches long, is fixed to the ceiling, and to the wall by a bracket; a short sleeve slides upon this rod, which can be clamped in any position, forms the pivot of the U-piece, *F*, embracing the 6-inch ratchet wheel, and which, by means of a set of double pawls, forces it to revolve in one direction or the other as may be desired upon a reciprocating movement being imparted to the rod, *B*. The pawls can readily be reversed upon their pins, so as to revolve the tool or polisher in the opposite direction; which it is sometimes necessary to do.

The vertical lever, *L*, is attached to the U not directly but by the diagonal arm or stretcher, *M*, the farther end of which can be raised or lowered on the lever, *L*, to determine the extent of its movement.

H is a wooden sleeve or handle slipped over the rod, *B*, which in working is grasped by both hands, and by its reciprocating movement imparts the primary motion to the machine.

When power is used, connecting rods (at right angles to each other) are attached to the rings, *a* and *e*, to give the direct stroke and the side motion to the rod, *B*.

The rod, *B*, being moved to and fro across the center of the glass, through the two ratchet wheels, *W* and *D*, causes the glass, *S*, and the tool, *G*, to revolve in the same direction, but at different rates.

For a glass 10-inch diameter the grinding tool is 8-inch and is to be worked with 3½-inch to 4-inch strokes, with as much regularity as possible, across the face of the glass, at the rate of 70 to 80 strokes per minute; at the same time a side movement of 1¼ to 1½ inches is

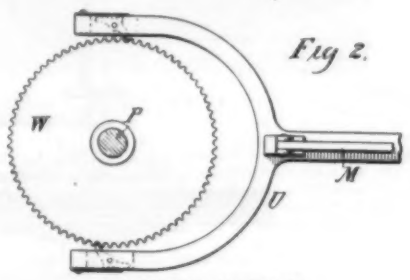


Fig 2.

RATCHET MOTION.

imparted to it, so as to bring the tool from side to side of the glass about every 8 strokes; at the end of 24 strokes, 3 or 4 circular, or rather elliptical, strokes are to be given, completing the cycle of 27 strokes. The side movement is to be so adjusted as not to allow the edge of the grinding tool, at the middle of its passage across the glass, to come within ¼ inch of the edge of the glass; this is a most important point.

I I are two parallel guides bracketed to the wall, to confine the lever, *L*, to its course; the rows of holes on each side of it are for the insertion of two pegs to limit the extent of its movements, thus regulating the stroke of the tool or polisher. The rod, *I*, which is swiveled in the end of the lever, *L*, is free to turn in its socket in a horizontal direction, to allow of any desired side movement of arm or tool. The joint at *Q* allows the arm to be raised when the rod, *B*, is lifted. A rod or arm at right angles to the arm, but not shown on drawing, is attached to the ring, *a*, in order to limit and control the amount of side movement of the tool or polisher. These checks of course are not needed where power is used, the stroke and side movement then being regulated by adjustable cranks, cams, or eccentrics, on the end of the power spindles.

For the grinding table of the machine a 10½-inch flat face plate, *V*, is screwed on the end, *Z*; to this is screwed a 16-inch slab of dry pine wood, composed of two half-inch pieces glued and nailed to each other cross grain, and afterward planed or turned perfectly flat, and varnished. It has two thicknesses of stout Canton flannel stretched over it, woolly side out, secured by tacks at the edges. On this is laid ¾-inch thickness of good soft felt or blankets, and over this again a piece of thick Canton flannel, woolly side down.

The flat back of the glass is smeared with thick shellac varnish; a disk of stout Canton flannel is immediately pressed upon it, leaving the woolly side outward, and when dry the edges are closely trimmed with a pair of scissors. The glass is then to be laid centrally upon the padded table (it will need no other support, either in grinding or in polishing), a heavy weight is then placed on it, and it is left all night to firmly imbed itself in its place. A file mark is made on the edge of the glass, and a corresponding indelible ink mark made on the Canton flannel cover, to insure its being always placed in precisely the same position.

(To be continued.)

HOW THE PYRAMIDS WERE BUILT.

PROF. GOODMAN, of the Yorkshire College, opened the winter session of the Keighley Association of Engineers a few days ago by a lecture on "The Tools and Methods Used in Building the Pyramids." The lecturer gave a brief description of the manner in which the early Egyptian temples were oriented, so as to secure that the light of certain stars should fall on the altar once a year, and how the slight "wobbling" of the earth's axis threw in time the passages out of truth. The pyramids seem to have been used first as astronomical observatories, and then as tombs, and that great pains were taken to secure that their sides were to the cardinal points. The working and jointing of the stones were of the highest class, and proved the use of long metal saws and skill and patience in producing their marvelously accurate lines and plane surfaces, by methods similar to those followed now. Hardened bronze appeared to have been largely used in sawing and drilling. The inclined plane and wedging and rocking seemed adequate to account for the raising of these huge masses of masonry, given the unlimited supply of labor available in ancient Egypt, especially during the three months of Nile flood. There was little doubt that the Egyptians were acquainted with the lathe.—Mechanical Engineer.

THE PRESENT CONDITION OF THE INDIGO INDUSTRY.

SINCE a previous article upon the above subject (November 1) was written, a report of the opening of the Hofmann house in Berlin has appeared in The Times. At the opening ceremony Prof. von Baeyer and Dr. Brunck delivered lectures upon the synthetical production of indigo. Von Baeyer's lecture dealt chiefly with the theoretical side of the question, while that of Dr. Brunck, who is one of the managing directors of the Badische Anilin und Soda Fabrik, dealt more upon the manufacturing side. As the work of von Baeyer is so well known and was referred to in the previous article, attention will only be drawn to the extremely interesting speech of Dr. Brunck.

In the first place, Dr. Brunck drew attention to the advantage of synthetic over natural or vegetable indigo, owing to its uniformity of composition, fine state of division, ready reducibility, etc. He claimed that a much less skilled operator may be employed in manipulating the dye bath than when natural indigo is used. He then went on to describe the prejudice which the synthetical indigo ("indigo pure") had to contend with when it was first placed on the market in 1897; it being stated by some that it was merely specially refined natural indigo, and by others that it was a substitute for indigo. It is extraordinary how difficult it is to make the public believe that it is possible to prepare in the laboratory a product which is identical in every respect to one which is of vegetable origin. In the case of indigo, however, there is perhaps some excuse, because the manufacturers of coal-tar products have often brought out colors which dye practically the same shades as indigo, but though not readily distinguished from it even by experts, have lacked one of the chief characteristics of indigo—fastness. But notwithstanding prejudice and keen competition, the development of the manufacture has been enormous. Dr. Brunck states that about £900,000 has been invested in the indigo department of the Badische Company, and that the quantity of indigo now annually manufactured by this company alone would require the cultivation of nearly 250,000 acres of land in India.

The method of manufacture employed by the Badische Company is that of Heumann, in which phenyl-glycine-ortho-carboxylic acid (anilido-acetic acid) is used with caustic soda (*cf.* Nature, this volume, p. 9). When this process was first discovered, the cost of the outgoing products was so great that indigo so prepared could not compete with the natural product. The Badische Company employ more than 100 highly trained research chemists; to some of these the work of endeavoring to elucidate the problem, how to manufacture phenyl-glycine-ortho-carboxylic acid cheaply, was intrusted. Taking naphthalene, which is obtained in enormous quantities from coal tar, as starting product, the following process was worked out. The naphthalene is oxidized by highly concentrated sulphuric acid in presence of mercury or mercury salts, with production of phthalic acid. The phthalic acid is then, by a series of reactions, converted into anthranilic acid, which, when combined with monochloracetic acid, produces phenyl-glycine-ortho-carboxylic acid. During the oxidation of naphthalene with sulphuric acid, large quantities of sulphur dioxide are produced, the loss of which would be a very serious expense. In preparing indigo upon the scale in which it is now manufactured, from 25,000 to 30,000 tons of sulphur dioxide are produced annually. But this is not lost; it is mixed with air and passed over heated oxide of iron, and is thus by catalytic action converted into sulphuric anhydride, and this by the action of water into sulphuric acid. Chlorine is required in order to prepare chloracetic acid, and caustic soda to fuse the phenyl-glycine-ortho-carboxylic acid. These two products are obtained by the electrolysis of sodium chloride. As, however, the chlorine as it is first produced is not sufficiently pure, it is purified by condensing it to the liquid condition. Attention has been drawn to the details of the manufacturing process, in order to show what a determined and powerful competition the Indian indigo producer has to face.

Synthetical indigo is being used in this country, but there is a considerable difference of opinion as to whether it is as easy to dye with the artificial as with the natural product. Some dyers state that there is a difficulty in obtaining the requisite bloom and that, therefore, materials dyed with it have a flat or dead appearance; other operators seem to find no such difficulty. Practically the only drawback to materials dyed with indigo is that the dye is inclined to rub. Some dyers say that goods dyed with synthetical indigo rub more than when dyed with the vegetable indigo. This again is denied by others. There is also to be a difficulty in introducing synthetical indigo. In print work synthetical indigo certainly appears to possess an advantage, owing to its fine state of division and to the fact of its containing no foreign matter which might scratch and injure the rollers. Before natural indigo can be employed, it is necessary to have it in an exceedingly fine state of division, and in order to insure this it is usually ground in a mill with water for several days. The artificial product, on the other hand, is sent into the market as a very fine powder or in the form of a paste. One drawback to natural indigo is the varying

amounts of indigotin which different samples contain. Artificial indigo contains not only a very high percentage of indigotin, but practically no foreign matter.

Dr. Brunck is sanguine that the synthetical product will shortly overcome all competition and drive the natural product from the market; and in his address, with a disinterestedness which cannot but be admired, advises the government of India to ascertain in what manner the land which has been employed for growing indigo may be best cultivated. If the advice of Dr. Brunck is taken, there will be no doubt as to the success of the artificial indigo. As showing the vast importance of the question to India, the following statistics are given. In Northern Behar there are from 250,000 to 300,000 acres of land devoted to the cultivation of indigo, and nearly one and a half million people are employed in the industry, while three years ago the capital invested in this province was estimated at over £4,000,000. The land under cultivation in Bengal was in 1899 estimated at 452,700 acres. There seems at last to be some movement among the dry bones; the Indigo Planters' Association have employed Mr. Rawson, who is an expert upon the chemistry of dyeing, to endeavor to improve the process of manufacturing indigo, and appeals are made to the government for help. The government is doing its part, and has ordered that all blue cloth supplied to the Army and Navy Clothing Departments shall be dyed with natural indigo. At the present time the price of natural and synthetic indigo is almost the same. What will the government do if the price of synthetic indigo becomes much less than that of natural indigo? Sir William Hudson, in August of this year, applied to the government for a loan for a scheme of sugar cultivation, suggesting that indigo and sugar-cane should be grown in rotation. The government, although not able to accede to his request, has sanctioned a committee to inquire into the possibilities of establishing the sugar industry in Behar.

When attention is drawn to the perilous position of the Indian indigo industry, letters are written to the papers by those connected with the production of indigo, making light of the danger, and referring to the "real indigo dye and German imitation." But, as Mr. Rawson, who at least is not likely to overrate the artificial indigo, said in his admirable lecture, delivered before the Society of Arts at the end of March, "all chemists, who have studied the question agreed that synthetic indigo is identically the same compound as the indigotin of natural indigo;" and again, "Provided the synthetic dye can be produced in sufficient quantity, the whole question of artificial versus natural indigo will resolve itself into one of cost." The Badische Company have spent nearly a million pounds in improving the manufacture of artificial indigo; at Höchst, the "Farben Fabrik" is also manufacturing artificial indigo, though at present they are only supplying the German market. In a letter to The Times on April 24, Prof. Armstrong asks: "Have we spent £5,000 in the endeavor to set our Indian indigo house in order?" For every British chemist employed, it is safe to say the Germans are employing fifty; for every pound spent, they are spending thousands. Is it not time to appoint a committee or commission of experts to see whether it may not be possible to increase the yield and quality of the indigo produced, and at the same time to produce it more economically?—F. Mollwo Perkin.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Packing for Tropical Countries.—Consul Hughes sends the following from Coburg, under date of October 8, 1900:

The Indian Import and Export Trades Journal calls the attention of shippers to the East Indies and other tropical countries to the proper methods of packing goods for shipment. It says:

"The effect of heavy rain in the tropics is to produce a dampness in the air quite unknown in Europe, and this is destructive to many articles of European manufacture. Mildew attacks textile goods, leather, books, and stationery; while arms, cutlery and metal work require constant attention to preserve them. No merchandise that is liable to injury from heat can be long stored in India without deterioration. The dampness of the air is such that a piece of woven fabric made and measured for length in this country will have different lengths in different parts of India. In Bombay, for example, closely-woven unsized calico exposed in the air in the shade in February, which is the dryest month of the year, varies as much as 3 per cent. in length from day to day. Nothing will keep steel or iron articles so well as lining the cases with bay wood or other absorbent timber, which has been well painted while hot with paraffin wax."

This applies just as well to goods shipped from the United States to Central and South America, the West Indies, and Mexico; the writer has often seen beautiful and costly goods shipped to these countries ruined by careless packing.

German vs. United States Consular System.—In his interesting book on the commercial treaties of 1903 (which lately was published by the German Bureau for the Preparation of Trade Treaties), Dr. Vosberg-Rekow, the well-known economist, says about United States consuls:

"The Americans have acted judiciously in establishing a system which is of the greatest advantage to themselves, but costly and inconvenient to their competitors. In all countries with which it has trade relations, the United States has stationed consuls and consular agents. Every shipment of goods to a United States port must pass through the hands of these officials, and the amount, value, place of origin, market price ruling in the country of production, method of production, etc., are noted. The consuls thus dive deeply into the economic condition of their districts, and obtain information the result of which is discernible in the steadily increasing exportations of their home country.

"Is this system worthy of our imitation?

"It has been held that this method is practicable for the United States, because its foreign trade is concentrated in a few ports, while Germany has innumerable inland customs offices. However, if our customs bureaus receive clear instructions, they will be able to transact the business satisfactorily. Besides, I believe this system will bring additional advantages. Our consulates, which should be greatly multiplied, would, without doubt, be easily maintained from the fees to be paid by the foreign shippers.

"The consul, vice-consul, and the consular agent should be professional officials, and not merchants whose interests lie with their business, as is now the case with our honorary or merchant consuls.

"Our consuls should be charged to study minutely and extensively the conditions of the export trade to their country and the working methods of the manufactories and business houses engaged in these exports. To afford them the opportunity for this work, we must prescribe requisite regulations for the importations of such foreign products."—Simon W. Hanauer, Vice Consul-General at Frankfort.

Spanish Sheep and Goat Skins.—Sheepskins.—Several kinds of sheep are bred in Spain, but the most valuable, on account of the excellent quality of the skins, are those found in the provinces of Murcia and Catalonia and in the district known as La Mancha, in New Castille; also, those in the Province of Extremadura, which, however, are esteemed more for their fine wool than for the pelt.

It is a notable fact that the finer the wool the poorer is the skin for tanning purposes.

It is in Extremadura that the celebrated Merino sheep are bred. Merino wool was at one time considered the finest obtainable in Europe, but, like many other natural sources of wealth in Spain, sheep farming has suffered from lack of enterprise and energy.

Spanish sheep are white, excepting those of La Mancha, which are black.

Sheep are classified under the heads of lambs and sheep or ewes. Until the animal is one year old, it is sold as a lamb. The skin of the lamb is used for making gloves, and is classified into "firsts" and "seconds," according to the fineness of the grain and the number of defects in the skin.

The skin of the Extremadura sheep is unsuitable for gloves, and can only be used for inferior articles.

In Millau and St. Julien, in France, in Yeovil, in England, and also in several parts of Germany, there are large tanneries devoted to the preparation of the skins exported from Murcia, Catalonia and La Mancha. These tanneries, either directly or through commission firms, send a large proportion of their output to the United States, which is an important market for glove skins.

When the animal is more fully grown, its skin can no longer be used for making gloves, and it is then applied to the manufacture of fancy goods, bookbinding, etc. Sheepskins are prepared in two ways: when tanned with sumac they are used for making cigar cases, pocketbooks, purses, etc.; but when required for leggings, aprons used by agricultural laborers, harness or anything that must be subjected to wear and tear, the skins are oak tanned. The former—i. e., those prepared with sumac—are extensively exported from Spain to Germany, whereas the latter find, or used to find, a good market in Cuba, Porto Rico and the Philippines.

The manner in which the skin is removed from the carcass is as follows: A small hole is made in one of the hind legs of the animal; a strong pair of bellows is then inserted into this little aperture, and air is blown in until the carcass is well swollen. The belly is then slit open from end to end and the skin carefully removed, if necessary, with the help of a knife.

The skins are collected by men who devote themselves exclusively to this work. After being exposed to the sun until a slight crust is formed on the flesh side, they are stretched on ropes in the shade until completely dried, and are then ready for export.

Goatskins.—These are produced in large quantities in the vicinity of Badajoz and generally in all the south of Spain. The skin of the very young kid is used only for ladies' fine gloves, and is prepared principally at Annonay and Grenoble, in France. These skins also find a market in the United States in a prepared state; but, with this sole exception, the entire supply of Spanish kid and goat skins is exported in the raw state to the United States for tanning into fine shoe leather, etc. This trade appears to be in the hands of French commission merchants, and I see no reason why our importers should not have their own buying agents in this country and secure their supplies at a much lower price. I shall be glad to give any firm the names of reliable agents who would execute their buying orders in the same way as is now done for the French middlemen.

The business is done here by direct contracts with the butchers, and also with sundry "collectors." These go around regularly to all the villages and bring the skins to the dealers in the towns.

In order to preserve the skins from damage by moths in summer, dealers use powdered naphthalene, which they sprinkle over them while they are being stacked.

For export, the skins are baled in small presses.—Julius G. Lay, Consul-General at Barcelona.

New Railroad Connection Between Quebec and Vermont.—I have to report the leasing and reconstruction of a railroad in my consular district, says United States Commercial Agent F. S. S. Johnson, of Stanbridge. The old road, owing to its inability to meet liabilities, was closed to traffic fourteen or fifteen years ago. The ties have decayed, and in many places the culverts have caved in; but in general, the roadbed is still in a fair condition. The Central Vermont Railroad (an American company) has leased this road for the term of ninety-nine years and has already commenced the work of reconstruction. New ties have been bought and steel rails will replace those which have become useless.

This road will open up a new agricultural section of Quebec and will in a measure increase the trade between this district and the United States. It extends from St. Lambert, near the end of the Victoria Bridge, opposite Montreal, via Chambly (this section is now built and in operation) to Frelighsburg and the Vermont line, a distance of 53 miles; from this point it extends to Sheldon Junction, a distance of 9 miles, where it connects with the Central Vermont Railroad, leading to St. Albans, a distance of 9 miles, and also with the Boston and Maine, running south to Cambridge Junction, and thence to Essex Junction and Burlington, Vt. From Cambridge Junction, the same line runs eastward to St. Johnsbury, connecting with the direct line of the Boston and Maine for Boston and all points south and west. The part of the road which is now being built is from Farnham to Sheldon Junction, Vt., a distance of about 25 miles. This road will in a measure injure a local traffic on the Canadian Pacific road from Farnham to Stanbridge, for the reason that freight will now be carried direct to places on the new road, instead of being delivered to Bedford for retransportation by teams.

Freight Rates from New York to Australia.—Consul-General Bray sends from Melbourne, October 6, 1900, clipping from The Melbourne Argus of even date having reference to the freight rates between the United States and the Australian colonies. Mr. Bray says:

For the past two weeks, freight rates between New York and the Australian colonies have fluctuated so that the sale of American goods has been materially retarded in these markets. If the manufacturers and exporters of the United States could induce the transportation companies to establish a more uniform rate between New York and Australasia, it would tend to obliterate the uncertainty as to cost of goods that has existed among merchants here. These colonies being such a long distance from the markets of the world, the freight rates are necessarily of considerable importance to the purchaser.

The article reads:

"We learn from cable messages received to-day that steamer rates from New York have advanced considerably, the quotations being 30s. ($7 30) per ton for weight and 45s. ($10.93) for measurement, kerosene being charged at 40s. ($9.73)—equal to 3d. (6 cents) per gallon. These rates are calculated to administer a check to the trade that has been growing up between the United States and Australia, affecting in particular low-priced goods. Not only have steamer freights advanced, but it is understood also that it is difficult to procure sufficient sailing vessels for the American-Australian trade, excepting at freights high enough to attract from other services.

"While conditions in other parts of the world may warrant a reduction in sailing vessel tonnage, the time is hardly ripe for it in the Australian trade. As a general rule, the substitution of steam for sail is a good thing; but an important exception is furnished when countries, like Australia, are far away from consuming markets, for distance must tell. Unfortunately, the high cost of sailing tonnage militates against the interests of producers of bulky articles like wool and grain. The obvious remedy is such an increase of production for export as will make the oceanic service more attractive to steamer lines and lead, in consequence, to competition for cargo and reduction of freights. The production must not only be large, but also of a varied nature, to secure the fullest freight advantages."

Electrical Goods in Calcutta.—Electricity as a motive power has not been used in Calcutta; but the Calcutta Tramway Company, Limited, is now preparing to change its lines from horse power to electricity, and the contract for the power station has been given to Messrs. Dick, Kerr & Company, Limited, of London. The first shipments for the plant are expected to arrive here in November or December of this year.

I have answered many letters from our various electrical companies relative to the use of electricity here, calling their attention to the proposed change in the tramway company's lines, and believe that, with proper efforts on their part, the contract might have been secured, as Americans are now competing successfully with the English companies, even in London.

Electricity is now beginning to be extensively used in Calcutta for various purposes, such as lighting, fans to take the place of punkhahs that were pulled by coolies, for driving machinery, etc., and there is an opening here for the sale of electrical machinery and goods, which our manufacturers should take advantage of.

I would advise correspondence with Messrs. Kilburn & Company here, who have an electrical plant and are furnishing electricity and electrical machinery and goods; also with the following named firms in Calcutta, who are dealers in such machinery and goods, viz., Osler & Company, Octavius Steel & Company and the Calcutta General Electrical Company.

All machinery is now entered duty free in India, but there is a duty of 5 per cent. ad valorem on goods.

There is a direct line of steamships between New York and Calcutta, but a cheaper freight on machinery and goods not required for immediate use would be by sailing vessels via the Cape.—R. F. Patterson, Consul-General at Calcutta.

Fruit Exports from Honduras.—Consul Johnston reports from Utilla, November 1, 1900. The shipment of cocoanuts for the last month has been large, on account of the high price ($23.85 gold per thousand). The crop is fully up to the average. Bananas for the last year have been raised in large quantities, and have sold for 50 centavos (23½ cents gold) a bunch. Owing to the good prices obtained for the products of the country, the import trade is on the increase, and traveling men everywhere report substantial orders and good business.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 901. December 3.—New German Steamship Line to South America—New German Bakery Regulations—Banks in Rio de Janeiro—Grain Exports from Russia.

No. 902. December 4.—Wireless Telegraphy between Belgium and England—Great Lakes and Hudson Bay Railway—Foot and Mouth Disease in France—*Italian Demand for Coal Pitch—*Cotton Crop in Central Asia—*New Railway Service between Moscow and Baku.

No. 903. December 5.—Stock Raising in Paraguay—Opening for Flax in Germany—German Merchant Flag Salute—Coal Sales at Gibraltar in October.

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No. 906. December 8.—*Tariff Legislation and Commercial Treaties in Germany—*German Sample Rooms in Constantinople—*Coal Discoveries in Austria-Hungary.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Reaumur Thermometers in Germany.—According to a communication of the German Chancellor, thermometers with the Réaumur scale will not be accepted any more for official test after January 1, 1901. The Prussian Minister of Instruction, therefore, has decreed that in all public hospitals and lunatic asylums, public baths, and high schools, the thermometers with division after Reaumur are to be replaced by such with the Centigrade scale according to the Celsius system.

Remedy for Chapped Hands.—A sure remedy for chapped hands consists in keeping them carefully dry and greasing them now and then with an anhydrous fat (not cold cream). The best substances for the purpose are Unguentum cereum or Oleum olivarum.

If the skin of the hands is already cracked, the following preparation will heal it:

Hand cosmetic for rendering the skin white and supple.—Finely ground zinc oxide, 5·0; bismuth oxychloride, 2·0; with fat oil, 12·0; next add glycerine, 5·0; lanolin, 30·0; and scent with rose water, 10·0.

Lanolin Powder.—Dissolve lanolin in ether, mix the solution with magnesium carbonate into a stiff mass, dry and triturate with talcum and starch.—Correspondenz-Blatt für Schweitzer Aerzte.

Dark Blue Marking Ink.—In a suitable kettle well mix, stirring constantly, 50 kilos. of liquid logwood extract (80 per cent.) with 3 liters of spirit previously mingled with 1 kilo. of hydrochloric acid, maintaining a temperature of 20° C. Next dissolve 5 kilos. of potassium chromate in 15 liters of boiling water; to this add 10 kilos. of hydrochloric acid, and pour this mixture, after raising the temperature to about 30° C., very slowly and with constant stirring into the kettle. Then heat the whole to 84° C. This mass, which has now assumed the nature of an extract, is stirred a little longer, and next 15 kilos. of dextrine mixed with 10 kilos. of fine white earth (white bole) are added. The whole is well stirred throughout. Now transfer the mass from the kettle into a crusher, where it is thoroughly worked through.—Lack u. Farben Zeitung.

Viscose.—An invention by Cross and Bevan, which seems worthy of thorough attention, is "viscose," a mucilaginous substance, which is obtained from cellulose by treatment with soda lye and carbon sulphide, and from which the cellulose used can be regenerated again with great readiness. Withal, the newly forming cellulose can be given, like in the plant, any desired shape, so that to-day by the aid of this invention we are able to produce cellulose in solid blocks or transparent tablets, or to spin it into extremely fine threads, which closely resemble silk, but cost only a few francs per kilo.

Viscose, in a liquid form, may also be added to paper pulp, and cellulose regenerated from it; the resulting paper in this case is not sized by a foreign body such as rosin or glue, but by cellulose, the substance of the paper fiber itself, which, as it were, causes the paper fibers to grow together.

Very durable paints may also be produced by the use of viscose, which are, of course, free from oils. On the other hand, a strongly alkaline viscose solution may be applied on old oil paint, which is thereby separated from its foundation and can be pulled off, together with the cellulose formed by the viscose, whereby the scratching off of old oil paint coatings, especially troublesome in the navy, is rendered entirely superfluous. Viscose is certainly a most remarkable invention, of which a good deal more will yet be heard. Its main fault lies in its diversity, which naturally retards its development.—Papier Zeitung.

English Red.—There are in commerce, under various names, such as caput mortuum, iron minium, etc., a number of red pigments whose chief component is iron oxide. Iron is known to be able to form a whole line of oxides. The hydrous oxide (hydrated sesquioxide of iron) is brown in color and constitutes the basis of the pigments generally known under the name of ocher. If same is subjected to the action of heat, it loses first of all its water, and assumes a dark brown color. The temperature being increased to red heat and white heat, one of those peculiar chemical processes takes place regarding which we are still completely in the dark. The ferric oxide acquires a number of red to violet-red shades. Whether the change in color is due to molecular restratification, to a crystallization, or else to absorption of some carbon or other minimal impurities, we do not know. No accurate statements regarding this question can be found in literature.

It is obtained technically by heating to a glowing heat either native or artificially produced ferric oxide in muffles or other suitable furnaces, e. g., brick furnaces. The product, more or less melted together, is ground in the usual way and levigated. An especially fine product of very brilliant shade is said to be obtained by heating ferrous oxalate to redness in muffles with admission of air. The ferric red thus produced is pulverulent at once. As a pigment English red is very permanent, it is not altered by hydrogen sulphide, it is acid-resisting and perfectly fast and weatherproof; both the mixing power and the covering power are quite considerable. Its commercial value is gaged by the shade, the division and percentage of ferric oxide. The various brands of commerce are more or less mixtures of iron red with gypsum, heavy spar and other extenders. It finds extensive employment in paint and as a polishing agent for glass. It is also much offered as a rust preventive, although its rust-preventing qualities are insignificant. That English red mixed with varnish and applied to iron has a rust-preventive effect on account of electro-chemical action is an unfounded presumption, for which no proof has been furnished as yet.

The chemical test is best conducted in the following manner:

1. A sample is heated in a porcelain crucible to feeble redness. The shade must be the same before and after the glowing.

2. A sample is boiled in rotation with ether, alcohol and water; the solvents must not take any color. English red should be only little soluble in hydrochloric acid.

3. Boil a sample with little water and filter off. The filtrate must not show any turbidity with barium chloride nor with ammonium carbonate.

4. Melt a sample with soda and examine in the usual manner for the presence of barium sulphate and silicic acid.—Dr. H. Loosen in Farben Zeitung.

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